

# HP 3PAR Red Hat Enterprise Linux and Oracle Linux Implementation Guide

## Abstract

This implementation guide provides the information you need to configure an HP 3PAR StoreServ Storage with Red Hat Enterprise Linux (RHEL) 4, RHEL 5, RHEL 6, and Oracle Linux (OL). General information is also provided on the basic steps required to allocate storage on the HP 3PAR StoreServ Storage that can then be accessed by the RHEL host.



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# 1 Introduction

This implementation guide provides the information you need to configure an HP 3PAR StoreServ Storage with Red Hat Enterprise Linux (RHEL) 4, RHEL 5, RHEL 6, and Oracle Linux (OL). General information is also provided on the basic steps required to allocate storage on the HP 3PAR StoreServ Storage that can then be accessed by the RHEL host.

**NOTE:** All references to RHEL also apply to Oracle Linux unless stated otherwise.

**Table 1 RHEL and Oracle Linux Releases**

RHEL Release	Oracle Linux Release
4.x	4.x
5.x	5.x
6.x	6.x

## Required

For predictable performance and results with your HP 3PAR StoreServ Storage, the information in this guide must be used in concert with the documentation set provided by HP for the HP 3PAR StoreServ Storage and the documentation provided by the vendor for their respective products.

## Supported Configurations

The following types of host connections are supported between the HP 3PAR StoreServ Storage and hosts running Linux OS:

- Fibre Channel (FC)
- Software iSCSI initiator
- Hardware iSCSI initiator
- Fibre Channel over Ethernet (FCoE)

**NOTE:** Hardware iSCSI and FCoE are not supported with Oracle Linux Unbreakable Enterprise Kernel (UEK).

Fibre Channel connections are supported between the HP 3PAR StoreServ Storage and the RHEL host in both a fabric-attached and direct-connect topology.

For information about supported hardware and software platforms, see the HP Single Point of Connectivity Knowledge (HP SPOCK) website:

[HP SPOCK](#)

For more information about HP 3PAR storage products, follow the links in “[HP 3PAR Storage Products](#)” (page 7).

**Table 2 HP 3PAR Storage Products**

Product	See...
HP 3PAR StoreServ 7000 Storage	<a href="#">HP Support Center</a>
HP 3PAR StoreServ 10000 Storage	<a href="#">HP Support Center</a>
HP 3PAR Storage Systems	<a href="#">HP Support Center</a>

**Table 2 HP 3PAR Storage Products** *(continued)*

Product	See...
HP 3PAR StoreServ Software — Device Management	<a href="#">HP Support Center</a>
HP 3PAR StoreServ Software—Replication	<a href="#">HP Support Center</a>

## HP 3PAR OS Upgrade Considerations

For information about planning an online HP 3PAR Operating System (HP 3PAR OS) upgrade, see the *HP 3PAR Operating System Upgrade Pre-Planning Guide*, which is available on the HP Support Center (SC) website:

[HP Support Center](#)

For complete details about supported host configurations and interoperability, consult the HP SPOCK website:

[HP SPOCK](#)

## Audience

This implementation guide is intended for system and storage administrators who monitor and direct system configurations and resource allocation for the HP 3PAR StoreServ Storage.

The tasks described in this manual assume that the administrator is familiar with RHEL 4, RHEL 5, RHEL 6, or Oracle Linux and the HP 3PAR OS.

This guide provides basic information that is required to establish communications between the HP 3PAR StoreServ Storage and the Red Hat Enterprise Linux or Oracle Linux host and to allocate the required storage for a given configuration. However, the appropriate HP documentation must be consulted in conjunction with the RHEL host and host bus adapter (HBA) vendor documentation for specific details and procedures.

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**NOTE:** This implementation guide is not intended to reproduce or replace any third-party product documentation. For details about devices such as hosts, HBAs, fabric switches, and non-HP 3PAR software management tools, consult the appropriate third-party documentation.

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## 2 Configuring the HP 3PAR StoreServ Storage for Fibre Channel

This chapter describes how to establish a connection between an HP 3PAR StoreServ Storage and an RHEL host using Fibre Channel and how to set up the fabric when running HP 3PAR OS 3.1.x, OS 2.3.x, or OS 2.2.x. For information on setting up the physical connection for a particular HP 3PAR StoreServ Storage, see the appropriate HP 3PAR installation manual.

### Required

If you are setting up a fabric along with your installation of the HP 3PAR StoreServ Storage, see [“Setting Up and Zoning the Fabric” \(page 14\)](#) before configuring or connecting your HP 3PAR StoreServ Storage.

## Configuring the HP 3PAR StoreServ Storage Running HP 3PAR OS 3.1.x or OS 2.3.x

This section describes how to configure the HP 3PAR StoreServ Storage running HP 3PAR OS 3.1.x or OS 2.3.x.

### Required

The following setup must be completed before connecting the HP 3PAR StoreServ Storage port to a device.

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**NOTE:** When deploying HP Virtual Connect Direct-Attach Fibre Channel storage for HP 3PAR StoreServ Storage systems, where the HP 3PAR StoreServ Storage ports are cabled directly to the uplink ports on the HP Virtual Connect FlexFabric 10 Gb/24-port Module for c-Class BladeSystem, follow the steps for configuring the HP 3PAR StoreServ Storage ports for a fabric connection.

For more information about HP Virtual Connect, HP Virtual Connect interconnect modules, and the HP Virtual Connect Direct-Attach Fibre Channel feature, see HP Virtual Connect documentation. To obtain this documentation, search the HP SC website:

[HP Support Center](#)

See also the *HP SAN Design Reference Guide*, available on the following website:

[HP SAN Design Reference Guide](#)

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## Configuring Ports on the HP 3PAR StoreServ Storage for a Direct Connection

To configure HP 3PAR StoreServ Storage ports for a direct connection to the RHEL host, complete the following steps:

1. To set up the HP 3PAR StoreServ Storage ports for a direct connection, issue the following set of commands with the appropriate parameters for each direct connect port:
  - a. `controlport offline <node:slot:port>`
  - b. `controlport config host -ct loop <node:slot:port>`  
where `-ct loop` specifies a direct connection.
  - c. `controlport rst <node:slot:port>`

Example:

```
# controlport offline 1:5:1
# controlport config host -ct loop 1:5:1
# controlport rst 1:5:1
```

2. After all ports have been configured, verify that the ports are configured for a host in a direct connection by issuing the `showport -par` command on the HP 3PAR StoreServ Storage. In the following example, `loop` denotes a direct connection and `point` denotes a fabric connection:

```
# showport -par
```

N:S:P	Connmode	ConnType	CfgRate	MaxRate	Class2	UniqNodeWwn	VCN	IntCoal
0:0:1	disk	loop	auto	2Gbps	disabled	disabled	disabled	enabled
0:0:2	disk	loop	auto	2Gbps	disabled	disabled	disabled	enabled
0:0:3	disk	loop	auto	2Gbps	disabled	disabled	disabled	enabled
0:0:4	disk	loop	auto	2Gbps	disabled	disabled	disabled	enabled
0:4:1	host	point	auto	4Gbps	disabled	disabled	disabled	enabled
0:4:2	host	point	auto	4Gbps	disabled	disabled	disabled	enabled
0:5:1	host	point	auto	2Gbps	disabled	disabled	disabled	enabled
0:5:2	host	loop	auto	2Gbps	disabled	disabled	disabled	enabled
0:5:3	host	point	auto	2Gbps	disabled	disabled	disabled	enabled
0:5:4	host	loop	auto	2Gbps	disabled	disabled	disabled	enabled
1:0:1	disk	loop	auto	2Gbps	disabled	disabled	disabled	enabled
1:0:2	disk	loop	auto	2Gbps	disabled	disabled	disabled	enabled
1:0:3	disk	loop	auto	2Gbps	disabled	disabled	disabled	enabled
1:0:4	disk	loop	auto	2Gbps	disabled	disabled	disabled	enabled
1:2:1	host	point	auto	2Gbps	disabled	disabled	disabled	enabled
1:2:2	host	loop	auto	2Gbps	disabled	disabled	disabled	enabled
1:4:1	host	point	auto	2Gbps	disabled	disabled	disabled	enabled
1:4:2	host	point	auto	2Gbps	disabled	disabled	disabled	enabled
1:5:1	host	loop	auto	4Gbps	disabled	disabled	disabled	enabled
1:5:2	host	loop	auto	4Gbps	disabled	disabled	disabled	enabled
1:5:3	host	loop	auto	4Gbps	disabled	disabled	disabled	enabled
1:5:4	host	loop	auto	4Gbps	disabled	disabled	disabled	enabled

## Configuring Ports on the HP 3PAR StoreServ Storage for a Fabric Connection

To configure HP 3PAR StoreServ Storage ports for a fabric connection, complete the following steps for each port connecting to a fabric.

- △ **CAUTION:** Before taking a port offline in preparation for a fabric connection, you should verify that the port has not been previously defined and that it is not already connected to a host, as this would interrupt the existing host connection. If an HP 3PAR StoreServ Storage port is already configured for a fabric connection, you can ignore step 2, since you do not have to take the port offline.

1. To determine whether a port has already been configured for a host port in fabric mode, issue `showport -par` on the HP 3PAR StoreServ Storage.

```
# showport -par
N:S:P Connmode ConnType CfgRate MaxRate Class2 UniqNodeWwn VCN IntCoal
0:0:1 disk loop auto 2Gbps disabled disabled disabled enabled
0:0:2 disk loop auto 2Gbps disabled disabled disabled enabled
0:0:3 disk loop auto 2Gbps disabled disabled disabled enabled
0:0:4 disk loop auto 2Gbps disabled disabled disabled enabled
0:4:1 host point auto 4Gbps disabled disabled disabled enabled
0:4:2 host point auto 4Gbps disabled disabled disabled enabled
0:5:1 host point auto 2Gbps disabled disabled disabled enabled
0:5:2 host loop auto 2Gbps disabled disabled disabled enabled
0:5:3 host point auto 2Gbps disabled disabled disabled enabled
0:5:4 host loop auto 2Gbps disabled disabled disabled enabled
1:0:1 disk loop auto 2Gbps disabled disabled disabled enabled
1:0:2 disk loop auto 2Gbps disabled disabled disabled enabled
1:0:3 disk loop auto 2Gbps disabled disabled disabled enabled
1:0:4 disk loop auto 2Gbps disabled disabled disabled enabled
1:2:1 host point auto 2Gbps disabled disabled disabled enabled
1:2:2 host loop auto 2Gbps disabled disabled disabled enabled
1:4:1 host point auto 2Gbps disabled disabled disabled enabled
1:4:2 host point auto 2Gbps disabled disabled disabled enabled
1:5:1 host point auto 4Gbps disabled disabled disabled enabled
1:5:2 host loop auto 4Gbps disabled disabled disabled enabled
1:5:3 host loop auto 4Gbps disabled disabled disabled enabled
1:5:4 host loop auto 4Gbps disabled disabled disabled enabled
```

2. If the port has *not* been configured, take the port offline before configuring it for connection to a host. To take the port offline, issue the HP 3PAR OS CLI command `controlport offline <node:slot:port>`.

```
# controlport offline 1:5:1
```

3. To configure the port to the host, issue `controlport config host -ct point <node:slot:port>`, where `-ct point` indicates that the connection type specified is a fabric connection. For example:

```
# controlport config host -ct point 1:5:1
```

4. Reset the port by issuing the `controlport rst <node:slot:port>` command.

```
# controlport rst 1:5:1
```

## Creating the Host Definition (HP 3PAR OS 3.1.x or OS 2.3.x)

Before connecting the RHEL host to the HP 3PAR StoreServ Storage, create a host definition that specifies a valid host persona for each HP 3PAR StoreServ Storage that is to be connected to a host HBA port through a fabric or a direct connection.

RHEL uses the generic host persona of 1 (UARepLun, SESLun) for HP 3PAR OS 3.1.2, 3.1.1, or earlier. Beginning with 3PAR OS 3.1.3, HP recommends using host persona 2 (UARepLUN, SESLun, ALUA).

1. To create host definitions, issue the `createhost [options] <hostname> [<WWN>...]` command. For example:

```
# createhost -persona 1 redhathost 1122334455667788 1122334455667799
```

**NOTE:** Changing an existing host persona from 1 to 2 is an offline process that requires a host reboot for the changes to take effect. The multipath configuration file `/etc/multipath.conf` must be changed to ALUA type for host persona 2 SCSI attributes to take effect. For the detailed procedure, see [“Modifying HP 3PAR Devices on the Host”](#) (page 115).

**NOTE:** To enable HP 3PAR Host Explorer functionality, HP recommends host persona 1 for hosts running RHEL 4 update 6 and later, RHEL 5.0 and later, or RHEL 6.1 and later.

Starting with the HP 3PAR OS 3.1.3 release, host persona 2 can also be used to support the HP 3PAR Host Explorer functionality on RHEL 5.8 and later or RHEL 6.1 and later.

Host persona 1 or 2 enables two functional features:

- Host\_Explorer, which requires the SESLun element of host persona 1 or 2
- UARepLun, which notifies the host of newly exported VLUNs and triggers a LUN discovery request on the host, making the VLUN automatically available.

Currently, none of the supported RHEL versions use the UARepLun, so you must manually scan the newly exported VLUNs.

Host persona 6 is automatically assigned following a rolling upgrade from HP 3PAR OS 2.2.x. If one or both of these features are to be used, the host persona value can be changed from 6 to 1 or 2 after the upgrade.

For host persona support in

**Table 3 Host Persona Support**

HP 3PAR OS	Supported Persona	Comment
HP 3PAR OS 2.3.1	6 1	Host Explorer Support on Persona 1
HP 3PAR OS 3.1.1, 3.1.2	1	
HP 3PAR OS 3.1.3	2 (recommended) 1	ALUA Support on Persona 2 HP Peer Motion support for single VV migration requires persona 2 Minimum OS requirement RHEL 5.8 and later or RHEL 6.1 and later.

**NOTE:** See the *HP 3PAR Command Line Interface Reference* or the *HP 3PAR Management Console Help* for complete details on using the `controlport`, `createhost`, and `showhost` commands.

These documents are available on the HP SC website:

[HP Support Center](#)

## Configuring the HP 3PAR StoreServ Storage Running HP 3PAR OS 2.2.x

This section describes how to configure an HP 3PAR StoreServ Storage running HP 3PAR OS 2.2.x.

## Required

The following setup must be completed before connecting the HP 3PAR StoreServ Storage port to a device.

## Configuring Ports for a Direct Connection

To configure the HP 3PAR StoreServ Storage ports for a direct connection, complete the following steps.

1. Set each HP 3PAR StoreServ Storage port to port persona 1 by issuing `controlport persona 1 <X:X:X>`, where `<X:X:X>` is the port location, expressed as `node:slot:port`.
2. Issue `controlport vcn disable -f <X:X:X>`.
3. Verify that each port has the appropriate persona defined:

```
# showport -par
N:S:P ConnTypeCfgrateClass2 VCN -----Persona----- IntCoal
4:0:2 loop      auto   disable disable *(1) g_ven, g_hba, g_os, 0, DC enabled
```

## Configuring Ports for a Fabric Connection

To configure the HP 3PAR StoreServ Storage ports for a fabric connection, complete the following steps.

### Procedure 1

1. Set each storage server port that will connect to a fabric to port persona 7 by issuing `controlport persona 7 <X:X:X>`, where `<X:X:X>` is the port location, expressed as `node:slot:port`.
2. Issue `controlport vcn disable -f <X:X:X>` for each port.
3. Verify that each port has the appropriate persona defined:

```
# showport -par
N:S:P ConnType CfgRate Class2 VCN -----Persona----- IntCoal
4:0:2 point      auto disable disable *(7) g_ven, g_hba, g_os, 0, FA enabled
```

## Creating the Host Definition (HP 3PAR OS 2.2.x)

Before connecting the RHEL host to the HP 3PAR StoreServ Storage, create a host definition for each HP 3PAR StoreServ Storage that is to be connected to a host HBA port through a fabric or a direct connection.

1. To create host definitions on the HP 3PAR StoreServ Storage, issue the following command:

```
# createhost [options] <hostname> [<WWN>]...
```

Example:

```
# createhost redhathost 1122334455667788 1122334455667799
```

2. To verify the host definition, issue the `showhost` command. For example:

```
# showhost
2 redhathost 1122334455667788 4:0:1
               1122334455667799 5:0:1
```

## Connecting the HP 3PAR StoreServ Storage to the Host

During this stage, connect the HP 3PAR StoreServ Storage to the host directly or to the fabric. This set of tasks includes physically cabling the HP 3PAR StoreServ Storage to the host or fabric.

## Setting Up and Zoning the Fabric

**NOTE:** This section does not apply when deploying HP Virtual Connect Direct-Attach Fibre Channel storage for HP 3PAR storage systems, where the HP 3PAR StoreServ Storage ports are cabled directly to the uplink ports on the HP Virtual Connect FlexFabric 10 Gb/24-port Module for c-Class BladeSystem. Zoning is automatically configured based on the Virtual Connect SAN Fabric and server profile definitions.

For more information about HP Virtual Connect, HP Virtual Connect interconnect modules, and the HP Virtual Connect Direct-Attach Fibre Channel feature, see HP Virtual Connect documentation. To obtain this documentation, search the HP SC website:

[HP Support Center](#)

See also the *HP SAN Design Reference Guide*, available on the following website:

Fabric zoning controls which Fibre Channel end-devices have access to each other on the fabric. Zoning also isolates the host and HP 3PAR StoreServ Storage ports from Registered State Change Notifications (RSCNs) that are irrelevant to these ports.

You can set up fabric zoning by associating the device World Wide Names (WWNs) or the switch ports with specified zones in the fabric. Although you can use either the WWN method or the port zoning method with the HP 3PAR StoreServ Storage, the WWN zoning method is recommended because the zone survives the changes of switch ports when cables are moved around on a fabric.

### Required

Employ fabric zoning, using the methods provided by the switch vendor, to create relationships between host HBA ports and storage server ports before connecting the host HBA ports or HP 3PAR StoreServ Storage ports to the fabric(s).

Fibre Channel switch vendors support the zoning of the fabric end-devices in different zoning configurations. There are advantages and disadvantages with each zoning configuration. Choose a zoning configuration based on your needs.

The HP 3PAR StoreServ Storage arrays support the following zoning configurations:

- One initiator to one target per zone
- One initiator to multiple targets per zone (zoning by HBA). This zoning configuration is recommended for the HP 3PAR StoreServ Storage. Zoning by HBA is required for coexistence with other HP Storage arrays.

**NOTE:** For high availability/clustered environments that require multiple initiators to access the same set of target ports, HP recommends that separate zones be created for each initiator with the same set of target ports.

**NOTE:** The storage targets in the zone can be from the same HP 3PAR StoreServ Storage, multiple HP 3PAR StoreServ Storages, or a mixture of HP 3PAR and other HP storage systems.

For more information about using one initiator to multiple targets per zone, see Zoning by HBA in the Best Practices chapter of the *HP SAN Design Reference Guide*. This document is available on the HP SC website:

[HP SAN Design Reference Guide](#)

If you use an unsupported zoning configuration and an issue occurs, HP may require that you implement one of the supported zoning configurations as part of the troubleshooting or corrective action.

After configuring zoning and connecting each host HBA port and HP 3PAR StoreServ Storage port to the fabric(s), verify the switch and zone configurations using the HP 3PAR OS CLI `showhost` command, to ensure that each initiator is zoned with the correct target(s).

## HP 3PAR Coexistence

The HP 3PAR StoreServ Storage array can coexist with other HP array families.

For supported HP arrays combinations and rules, see the *HP SAN Design Reference Guide*, available on the following website:

[HP SAN Design Reference Guide](#)

## Configuration Guidelines for Fabric Vendors

Use the following fabric vendor guidelines before configuring ports on fabric(s) to which the HP 3PAR StoreServ Storage connects.

- Brocade switch ports that connect to a host HBA port or to an HP 3PAR StoreServ Storage port should be set to their default mode. On Brocade 3xxx switches running Brocade firmware 3.0.2 or later, verify that each switch port is in the correct mode using the Brocade telnet interface and the `portcfgshow` command, as follows:

```
brocade2_1:admin> portcfgshow
Ports          0  1  2  3      4  5  6  7
-----+-----+-----+-----+-----+-----+-----+-----
Speed          AN AN AN AN      AN AN AN AN
Trunk Port      ON ON ON ON      ON ON ON ON
Locked L_Port   .. .. .. ..      .. .. .. ..
Locked G_Port   .. .. .. ..      .. .. .. ..
Disabled E_Port .. .. .. ..      .. .. .. ..
where AN:AutoNegotiate, ..:OFF, ??:INVALID.
```

The following fill-word modes are supported on a Brocade 8 G/s switch running FOS firmware 6.3.1a and later:

```
admin>portcfgfillword
Usage: portCfgFillWord PortNumber Mode [Passive]
Mode: 0/-idle-idle - IDLE in Link Init, IDLE as fill word (default)
       1/-arbff-arbff - ARBFF in Link Init, ARBFF as fill word
       2/-idle-arbff - IDLE in Link Init, ARBFF as fill word (SW)
       3/-aa-then-ia - If ARBFF/ARBFF failed, then do IDLE/ARBFF
```

HP recommends that you set the fill word to mode 3 (aa-then-ia), which is the preferred mode using the `portcfgfillword` command. If the fill word is not correctly set, `er_bad_os` counters (invalid ordered set) will increase when you use the `portstatsshow` command while connected to 8 G HBA ports, as they need the ARBFF-ARBFF fill word. Mode 3 will also work correctly for lower-speed HBAs, such as 4 Gb/2 Gb HBAs. For more information, see the *Fabric OS Command Reference Manual* and the FOS release notes, available on the Brocade website:

[Brocade](#)



In addition, some HP switches, such as the HP SN8000B 8-slot SAN backbone director switch, the HP SN8000B 4-slot SAN director switch, the HP SN6000B 16 Gb FC switch, or the HP SN3000B 16 Gb FC switch automatically select the proper fill-word mode 3 as the default setting.

- McDATA switch or director ports should be in their default modes as **G** or **GX-port** (depending on the switch model), with their speed setting permitting them to autonegotiate.
- Cisco switch ports that connect to HP 3PAR StoreServ Storage ports or host HBA ports should be set to **AdminMode = FX** and **AdminSpeed = auto port**, with the speed set to **auto negotiate**.
- QLogic switch ports should be set to port type **GL-port** and port speed **auto-detect**. QLogic switch ports that connect to the HP 3PAR StoreServ Storage should be set to I/O Stream Guard **disable** or **auto**, but never **enable**.

## Target Port Limits and Specifications for FC

To avoid overwhelming a target port and ensure continuous I/O operations, observe the following limitations on a target port:

- See the *HP 3PAR Support Matrix* at the HP SPOCK website and adhere to the maximum number of initiator connection supported per array port, per array node pair, and per array: [HP SPOCK](#)
- I/O queue depth on each HP 3PAR StoreServ Storage HBA model, as follows:
  - QLogic 2G: 497
  - LSI 2G: 510
  - Emulex 4G: 959
  - HP 3PAR HBA 4G: 1638
  - HP 3PAR HBA 8G: 3276 (HP 3PAR StoreServ 10000 and HP 3PAR StoreServ 7000 systems only)
- The I/O queues are shared among the connected host HBA ports on a first-come, first-served basis.
- When all queues are in use and a host HBA port tries to initiate I/O, it receives a target queue full response from the HP 3PAR StoreServ Storage port. This condition can result in erratic I/O performance on each host. If this condition occurs, each host should be throttled so that it cannot overrun the HP 3PAR StoreServ Storage port's queues when all hosts are delivering their maximum number of I/O requests.

---

**NOTE:** When host ports can access multiple targets on fabric zones, the assigned target number assigned by the host driver for each discovered target can change when the host is booted and some targets are not present in the zone. This situation may change the device node access point for devices during a host reboot. This issue can occur with any fabric-connected storage, and is not specific to the HP 3PAR StoreServ Storage.

---

## HP 3PAR Priority Optimization

The HP 3PAR Priority Optimization feature introduced in HP 3PAR OS 3.1.2. MU2 is a more efficient and dynamic solution for managing server workloads and can be utilized as an alternative to setting host I/O throttles. Using this feature, a storage administrator is able to share storage resources more effectively by enforcing quality of service limits on the array. No special settings are needed on the host side to obtain the benefit of priority optimization although certain per target or per adapter throttle settings may need to be adjusted in rare cases. For complete details about how to use HP 3PAR Priority Optimization (Quality of Service) on HP 3PAR StoreServ Storage



arrays, see the *HP 3PAR Priority Optimization* technical whitepaper, which is available on the HP SC website:

[HP 3PAR Priority Optimization](#)

## HP 3PAR OS Persistent Ports

The HP 3PAR OS Persistent Ports (or virtual ports) feature minimizes I/O disruption during an HP 3PAR StoreServ Storage online upgrade or node-down event (online upgrade, node reboot, or cable pull test). Port shutdown or reset events do not trigger this feature.

Each FC target storage array port has a partner array port automatically assigned by the system. Partner ports are assigned across array node pairs.

HP 3PAR OS Persistent Ports allows an HP 3PAR StoreServ Storage FC port to assume the identity (port IP address) of a failed port while retaining its own identity. Where a given physical port assumes the identity of its partner port, the assumed port is designated as a persistent port. Array port failover and failback with HP 3PAR OS Persistent Ports is transparent to most host-based multipathing software, which can keep all of its I/O paths active.

---

**NOTE:** Use of HP 3PAR OS Persistent Ports technology does not negate the need for properly installed, configured, and maintained host multipathing software.

---

For a more complete description of the HP 3PAR OS Persistent Ports feature, its operation, and a complete list of required setup and connectivity guidelines, see:

- The HP Technical white paper *HP 3PAR StoreServ Persistent Ports* (HP document #F4AA4-4545ENW)

This document is available on the following HP SC website:

[HP Support Center](#)

- The *HP 3PAR Command Line Interface Administrator's Manual*, "Using Persistent Ports for Nondisruptive Online Software Upgrades"

This document is available on the following HP SC website:

[HP Support Center](#)

## Fibre Channel

### HP 3PAR OS Persistent Ports Setup and Connectivity Guidelines for FC

Starting with HP 3PAR OS 3.1.2, the HP 3PAR OS Persistent Ports feature is supported for FC target ports.

Starting with HP 3PAR OS 3.1.3, the Persistent Port feature has additional functionality to minimize I/O disruption during an array port "loss\_sync" event triggered by a loss of array port connectivity to fabric.

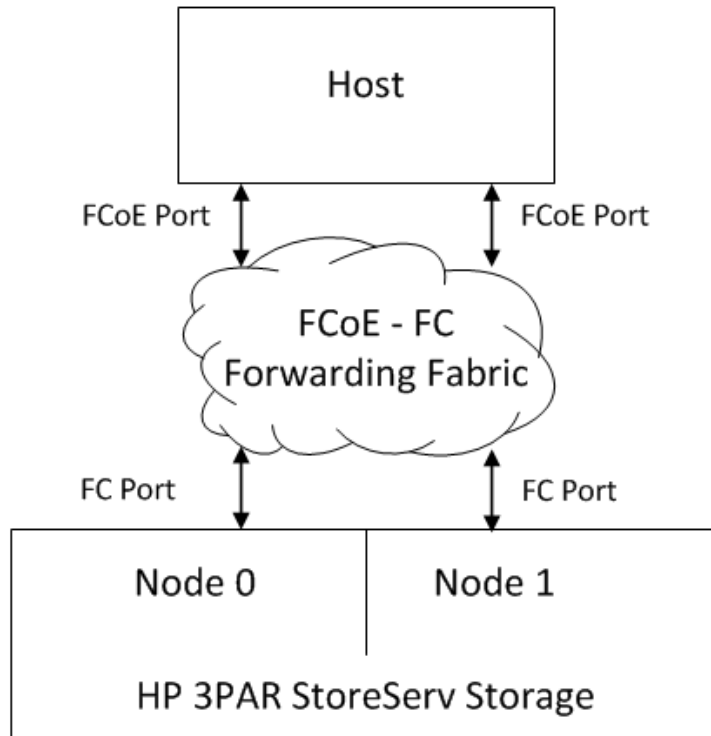
Specific cabling setup and connectivity guidelines need to be followed for HP 3PAR OS Persistent Ports to function properly:

- HP 3PAR StoreServ Storage FC partner ports must be connected to the same FC fabric, and preferably to different FC switches on the fabric.
- The FC fabric being used must support NPIV, and NPIV must be enabled.
- The host-facing HBAs must be configured for point-to-point fabric connection (there is no support for direct-connect "loops").

## FCoE-to-FC Connectivity

The following figures show a basic diagram of FCoE-to-FC connectivity.

**Figure 1 Initiator FCoE to FC Target**

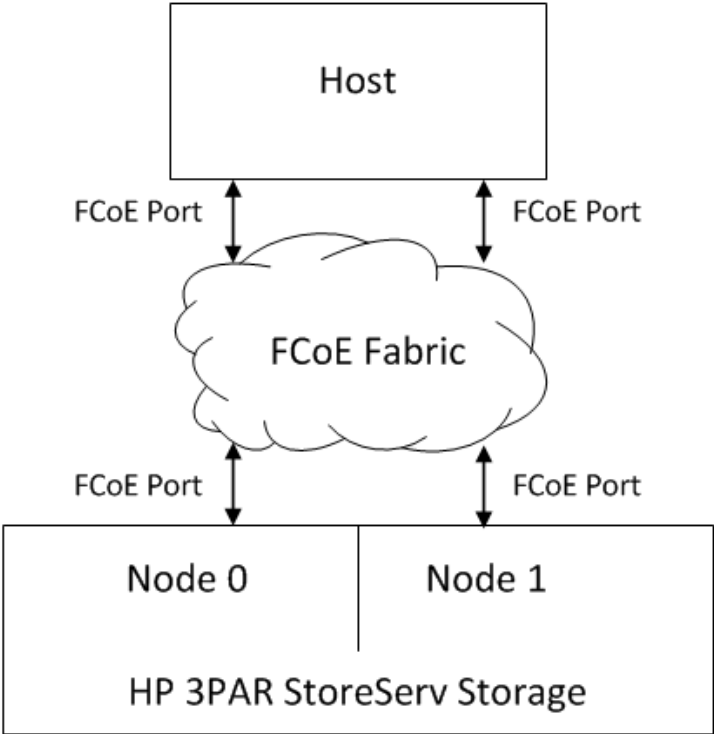


---

**NOTE:** For [Figure 1 \(page 18\)](#), the FCoE switch must be able to convert FCoE traffic to FC and must also be able to trunk this traffic to the fabric that the HP 3PAR StoreServ Storage target ports are connected to. FCoE switch VLANs and routing setup and configuration are beyond the scope of this implementation guide. Consult your switch manufacturer's documentation for instructions of how to set up VLANs and routing.

---

Figure 2 Initiator FCoE to Target FCoE



# 3 Configuring the HP 3PAR StoreServ Storage for iSCSI

## Configuring Ports for an iSCSI Connection

To configure an iSCSI target port on the HP 3PAR StoreServ Storage for connection to an iSCSI Initiator, complete the following steps:

**NOTE:** The method for configuring software iSCSI on the HP 3PAR StoreServ Storage is the same as for configuring hardware iSCSI.

1. 10 Gb iSCSI ports on HP 3PAR StoreServ 10000 and HP 3PAR StoreServ 7000 arrays require a one-time configuration using the `controlport` command. (HP 3PAR S-Class, T-Class, and F-Class do not support 10 Gb HBAs). Use the `showport` and `showport -i` commands to verify the configuration setting.

For example:

```
# showport
N:S:P      Mode      State ----Node_WWN---- -Port_WWN/HW_Addr- Type Protocol
0:3:1 suspended config_wait - - cna -
0:3:2 suspended config_wait - - cna -

# showport -i
N:S:P Brand Model Rev Firmware Serial HWType
0:3:1 QLOGIC QLE8242 58 0.0.0.0 PCGLT0ARC1K3SK CNA
0:3:2 QLOGIC QLE8242 58 0.0.0.0 PCGLT0ARC1K3SK CNA
```

2. If `State=config_wait` or `Firmware=0.0.0.0`, use the `controlport config iscsi <n:s:p>` command to configure. Use the `showport` and `showport -i` commands to verify the configuration setting.

For example:

```
# controlport config iscsi 0:3:1
# controlport config iscsi 0:3:2
# showport
N:S:P      Mode      State ----Node_WWN---- -Port_WWN/HW_Addr- Type Protocol
...
0:3:1 target ready - 2C27D7521F3E iscsi iSCSI
0:3:2 target ready - 2C27D7521F3A iscsi iSCSI
# showport -i
...
N:S:P Brand Model Rev Firmware Serial HWType
...
0:3:1 QLOGIC QLE8242 58 4.8.76.48015 PCGLT0ARC1K3U6 CNA
0:3:2 QLOGIC QLE8242 58 4.8.76.48015 PCGLT0ARC1K3U6 CNA
```

3. Check the current settings of the iSCSI ports by issuing `showport -iscsi`.

```
# showport -iscsi
N:S:P State IPAddr Netmask Gateway TPGT MTU Rate DHCP iSNS_Prim iSNS_Sec iSNS_Port
0:3:1 offline 0.0.0.0 0.0.0.0 0.0.0.0 31 1500 n/a 0 0.0.0.0 0.0.0.0 3205
0:3:2 loss_sync 0.0.0.0 0.0.0.0 0.0.0.0 32 1500 n/a 0 0.0.0.0 0.0.0.0 3205
1:3:1 offline 0.0.0.0 0.0.0.0 0.0.0.0 131 1500 n/a 0 0.0.0.0 0.0.0.0 3205
1:3:2 loss_sync 0.0.0.0 0.0.0.0 0.0.0.0 132 1500 n/a 0 0.0.0.0 0.0.0.0 3205
-----
4
```

- Set up the IP address and netmask address of the iSCSI target ports by issuing `controliscsiport addr <ipaddr> <netmask> [-f] <node:slot:port>`.

```
# controliscsiport addr 10.100.0.101 255.255.0.0 -f 0:3:1
# controliscsiport addr 10.101.0.201 255.255.0.0 -f 1:3:1
```

- Verify the changed settings by issuing `showport -iscsi`.

```
# showport -iscsi
N:S:P State IPAddr Netmask Gateway TPGT MTU Rate DHCP iSNS_Addr iSNS_Port
0:3:1 ready 10.100.0.101 255.255.0.0 0.0.0.0 31 1500 10Gbps 0 0.0.0.0 3205
0:3:2 loss sync 0.0.0.0 0.0.0.0 0.0.0.0 32 1500 n/a 0 0.0.0.0 3205
1:3:1 ready 10.101.0.201 255.255.0.0 0.0.0.0 131 1500 10Gbps 0 0.0.0.0 3205
1:3:2 loss sync 0.0.0.0 0.0.0.0 0.0.0.0 132 1500 n/a 0 0.0.0.0 3205
-----
4
```

**NOTE:** Make sure that VLAN connectivity is working properly. See [“Setting Up the Switch and iSCSI Initiator”](#) (page 57)

- Issue the `controliscsiport ping <ipaddr> <node:slot:port>` command to verify that the switch ports where the HP 3PAR StoreServ Storage iSCSI target ports and iSCSI Initiator host connect are visible to each other.

```
# controliscsiport ping 10.100.0.101 0:3:1
Ping succeeded
# controliscsiport ping 10.101.0.201 1:3:1
Ping succeeded
```

**NOTE:** When the host initiator port and the HP 3PAR OS target port are in different IP subnets, the gateway address for the HP 3PAR OS port should be configured in order to avoid unexpected behavior by issuing the `controliscsiport gw <gw_address> [-f] <node:slot:port>` command.

```
# controliscsiport gw 10.100.0.1 -f 0:3:1
# controliscsiport gw 10.101.0.1 -f 1:3:1
```

To verify that the gateway address for the HP 3PAR OS port is configured, issue the following command:

```
# showport -iscsi
N:S:P State IPAddr Netmask Gateway TPGT MTU Rate DHCP iSNS_Addr iSNS_Port
0:3:1 ready 10.100.0.101 255.255.0.0 10.100.0.1 31 1500 10Gbps 0 0.0.0.0 3205
0:3:2 loss sync 0.0.0.0 0.0.0.0 0.0.0.0 32 1500 n/a 0 0.0.0.0 3205
1:3:1 ready 10.101.0.201 255.255.0.0 10.101.0.1 131 1500 10Gbps 0 0.0.0.0 3205
1:3:2 loss sync 0.0.0.0 0.0.0.0 0.0.0.0 132 1500 n/a 0 0.0.0.0 3205
-----
4
```

## Creating the iSCSI Host Definition

This section describes how to create an iSCSI host definition.

To set up a hardware iSCSI host definition, see [“Setting Up Hardware iSCSI for RHEL 6 or RHEL 5”](#) (page 60).

**NOTE:** If multiple initiator ports are used, add the following to `/etc/sysctl.conf`:

```
net.ipv4.conf.all.arp_filter = 1
```

**NOTE:** To be able to establish an iSCSI Initiator connection/session with the iSCSI target port from the host, you must create a host definition entry, create the iSCSI host definition, and configure the HP 3PAR StoreServ Storage iSCSI target port(s).

For details, see [“Creating the Software iSCSI Connection in RHEL 6 or RHEL 5 Using the iscsiadm Command”](#) (page 79).

To get the software iSCSI initiator name, issue the following command on the host:

```
# cat /etc/iscsi/initiatorname.iscsi
Initiator Name=iqn.1994-05.com.redhat:a3df53b0a32dS
```

To get the hardware iSCSI initiator name for Emulex CNAs, press **Ctrl-S** through the BIOS, the hbacmd utility, or the ocmanager UI:

```
# hbacmd GetInitiatorProperties 28-92-4a-af-f5-61
Initiator login options for 28-92-4a-af-f5-61:
Initiator iSCSI Name: iqn.1990-07.com.emulex:28-92-4a-af-f5-61
```

See “iSCSI Commands” in the *OneCommand™Manager Command Line Interface Version 6.1 User Manual*, which is available at the following website:

[Emulex](#)

1. To configure 10 G iSCSI on the host, Use the Emulex OneCommand Manager command `/usr/sbin/ocmanager/hbacmd` or the QLogic QConvergeConsole Manager command `/opt/QLogic_Corporation/QConvergeConsoleCLI/qauccli` to find the MAC address for the 10 Gb CNA, and then assign an IP address to the 10 Gb NIC port.

**NOTE:** Currently, hardware iSCSI is supported only on the following models: only HP NC551/553/FlexFabric 554/CN1100E support hardware iSCSI

- HP NC551
- HP NC553
- HP FlexFabric 554
- HP CN1100E

Example:

```
# lspci | grep 10G
06:00.0 Ethernet controller: QLogic Corp. cLQM8214 1/10GbE Controller (rev 54)
06:00.1 Ethernet controller: QLogic Corp. cLQM8214 1/10GbE Controller (rev 54)
06:00.4 Network controller: QLogic Corp. 8200 Series 10GbE Converged Network Adapter (iSCSI) (rev 54)
06:00.5 Network controller: QLogic Corp. 8200 Series 10GbE Converged Network Adapter (iSCSI) (rev 54)
06:00.6 Fibre Channel: QLogic Corp. 8200 Series 10GbE Converged Network Adapter (FCoE) (rev 54)
06:00.7 Fibre Channel: QLogic Corp. 8200 Series 10GbE Converged Network Adapter (FCoE) (rev 54)
```

Use the `gauccli` command to find the MAC address for the 10 Gb CNA, followed by assigning an IP address to the 10 Gb NIC port.

2. You can verify that the iSCSI Initiator is connected to the iSCSI target port by using the HP 3PAR OS CLI `showhost` command.

```
# showhost
Id Name          Persona      -----WWN/iSCSI_Name----- Port
--
                                iqn.1994-05.com.redhat:a3df53b0a32d 0:3:1
                                iqn.1994-05.com.redhat:a3df53b0a32d 1:3:1
```

**NOTE:** To enable HP 3PAR Host Explorer functionality, HP recommends host persona 1 for hosts running RHEL 4 update 6 and later, RHEL 5.0 and later, or RHEL 6.1 and later.

Starting with the HP 3PAR OS 3.1.3 release, host persona 2 can also be used to support the HP 3PAR Host Explorer functionality on RHEL 5.8 and later or RHEL 6.1 and later.

However, host persona 6 is automatically assigned following a rolling upgrade from HP 3PAR OS 2.2.x. It is required to change host persona 6 after an upgrade to host persona 1 or 2.

Host persona 1 or 2 enables two functional features:

- `Host_Explorer`, which requires the `SESLun` element of host persona 1 or 2
- `UARepLun`, which notifies the host of newly exported VLUNs and triggers a LUN discovery request on the host, making the VLUN automatically available. Currently, none of the supported RHEL versions use the `UARepLun`, so you must manually scan the newly exported VLUNs.

3. Create an iSCSI host definition entry by using the HP 3PAR OS CLI `createhost -iscsi <host name> <iSCSI Initiator name>` command.

- On an HP 3PAR StoreServ Storage running HP 3PAR OS 3.1.2 or earlier, use `createhost` with the `-persona 1` option. For example:

```
# createhost -iscsi -persona 1 redhathost iqn.1994-05.com.redhat:a3df53b0a32d
```

- On an HP 3PAR StoreServ Storage running HP 3PAR OS 3.1.3, create an iSCSI host definition by using the following command:

```
# createhost -iscsi -persona 2 redhathost iqn.1994-05.com.redhat:a3df53b0a32d
```

4. Verify that the host entry has been created.

Example for an HP 3PAR StoreServ Storage array running HP 3PAR OS 3.1.3 or later:

```
# showhost
Id Name          Persona      -----WWN/iSCSI_Name----- Port
0  redhathost    Generic-ALUA  iqn.1994-05.com.redhat:a3df53b0a32d 0:3:1
                                iqn.1994-05.com.redhat:a3df53b0a32d 1:3:1
```

Example for an HP 3PAR array running HP 3PAR OS 2.3.x or OS 3.1.2 or earlier:

```
# showhost
Id Name      Persona  -----WWN/iSCSI_Name-----      Port
redhathost   Generic  iqn.1994-05.com.redhat:a3df53b0a32d  0:3:1
              iqn.1994-05.com.redhat:a3df53b0a32d  1:3:1
```

**NOTE:** For an HP 3PAR StoreServ Storage system running HP 3PAR OS 2.2.x, the output of `showhost` appears differently, since there are no `Persona` fields.

Example of `showhost` output for an HP 3PAR StoreServ Storage system running HP 3PAR OS 2.2.x:

```
# showhost
Id Name -----WWN/iSCSI_Name-----      Port
0  linux iqn.1994-05.com.redhat:a3df53b0a32d  0:3:1
      iqn.1994-05.com.redhat:a3df53b0a32d  1:3:1
```

## RHEL `iscsiadm` Utility Usage

This section provides examples of a few commands using the `iscsiadm` utility to set up the iSCSI sessions:

- Discover iSCSI targets:

```
# iscsiadm -m discovery -t sendtargets -p 10.0.0.10:3260
```

- iSCSI login:

```
# iscsiadm -m node -T iqn.2000-05.com.3pardata:20110002ac0001a6 -p 10.0.0.10:3260 -l
```

- iSCSI logout:

```
# iscsiadm -m node -T iqn.2000-05.com.3pardata:20110002ac0001a6 -p 10.0.0.10:3260 -u
```

- iSCSI logout all:

```
# iscsiadm -m node --logoutall=all
```

- Add custom iSCSI node:

```
# iscsiadm -m node -o new -p 10.0.0.30:3260
```



- Remove iSCSI node:

```
# iscsiadm -m node -o delete -T iqn.2000-05.com.3pardata:20110002ac0001a6 -p 10.0.0.10:3260
```

- Remove iSCSI targets:

```
# iscsiadm -m discovery -o delete -p 10.0.0.10
```

- Display iSCSI node configuration:

```
# iscsiadm -m node -T iqn.2000-05.com.3pardata:21110002ac0001a6 -p 10.0.0.20:3260
```

- Show all records in discovery database:

```
# iscsiadm -m discovery
```

- Show discovery record setting:

```
# iscsiadm -m discovery -p 10.0.0.10:3260
```

- Show all node records

- Display session statistics:

```
# iscsiadm -m session -r 1 --stats
```

- Display session and device information:

```
# iscsiadm -m session
```

- Rescan iSCSI LUNs or sessions:

```
# iscsiadm -m session -R
```

For more information about iscsi-initiator-utils packages, see `/usr/share/doc`.

## Target Port Limits and Specifications for iSCSI

To avoid overwhelming a target port and ensure continuous I/O operations, observe the following limitations on a target port:

- I/O queue depth on each HP 3PAR StoreServ Storage HBA model, as follows:
  - QLogic 1G: 512
  - QLogic 10G: 2048 (HP 3PAR StoreServ 10000 and HP 3PAR StoreServ 7000 systems only)
- The I/O queues are shared among the connected host HBA ports on a first-come, first-served basis.
- When all queues are in use and a host HBA port tries to initiate I/O, it receives a target queue full response from the HP 3PAR StoreServ Storage port. This condition can result in erratic I/O performance on each host. If this condition occurs, each host should be throttled so that it cannot overrun the HP 3PAR StoreServ Storage port's queues when all hosts are delivering their maximum number of I/O requests.

## HP 3PAR Priority Optimization

The HP 3PAR Priority Optimization feature introduced in HP 3PAR OS 3.1.2. MU2 is a more efficient and dynamic solution for managing server workloads and can be utilized as an alternative to setting host I/O throttles. Using this feature, a storage administrator is able to share storage resources more effectively by enforcing quality of service limits on the array. No special settings are needed on the host side to obtain the benefit of HP 3PAR Priority Optimization although certain per target or per adapter throttle settings may need to be adjusted in rare cases. For complete details of how to use HP 3PAR Priority Optimization (Quality of Service) on HP 3PAR StoreServ Storage arrays, see the *HP 3PAR Priority Optimization* technical white paper available at the following website:

[HP 3PAR Priority Optimization](#)

## HP 3PAR OS Persistent Ports

The HP 3PAR OS Persistent Ports (or virtual ports) feature minimizes I/O disruption during an HP 3PAR StoreServ Storage online upgrade or node-down event (online upgrade, node reboot, or cable pull test). Port shutdown or reset events do not trigger this feature.

Each iSCSI target storage array port has a partner array port automatically assigned by the system. Partner ports are assigned across array node pairs.

HP 3PAR OS Persistent Ports allows an HP 3PAR StoreServ Storage iSCSI port to assume the identity (port IP address) of a failed port while retaining its own identity. Where a given physical port assumes the identity of its partner port, the assumed port is designated as a persistent port. Array port failover and failback with HP 3PAR OS Persistent Ports is transparent to most host-based multipathing software, which can keep all of its I/O paths active.

---

**NOTE:** Use of HP 3PAR OS Persistent Ports technology does not negate the need for properly installed, configured, and maintained host multipathing software.

---

For a more complete description of the HP 3PAR OS Persistent Ports feature, its operation, and a complete list of required setup and connectivity guidelines, see:

- The HP Technical white paper *HP 3PAR StoreServ Persistent Ports* (HP document #F4AA4-4545ENW)

This document is available on the following HP SC website:

[HP Support Center](#)

- The *HP 3PAR Command Line Interface Administrator's Manual*, "Using Persistent Ports for Nondisruptive Online Software Upgrades"

This document is available on the following HP SC website:

[HP Support Center](#)

## iSCSI

### HP 3PAR OS Persistent Ports Setup and Connectivity Guidelines for iSCSI

Starting with HP 3PAR OS 3.1.3, the HP 3PAR OS Persistent Ports feature is supported for iSCSI. The HP 3PAR OS Persistent Ports feature is enabled by default for HP 3PAR StoreServ Storage iSCSI ports during node-down events.

Specific cabling setup and connectivity guidelines need to be followed for HP 3PAR OS Persistent Ports to function properly.

A key element for iSCSI connectivity is that partner ports must share the same IP network.

The same host port on host-facing CNAs in the nodes of a node pair must be connected to the same IP network, and preferably to different IP switches on the fabric (for example, 0:1:1 and 1:1:1).

## 4 Configuring the HP 3PAR StoreServ Storage for FCoE

### Setting Up the FCoE Switch, FCoE Initiator, and FCoE target ports

Connect the Linux host FCoE initiator port(s) and the HP 3PAR StoreServ Storage FCoE target ports to the FCoE switch(es).

**NOTE:** FCoE switch VLANs and routing setup and configuration is beyond the scope of this document. Consult your switch manufacturer's documentation for instructions of how to set up VLANs and routing.

1. CNA ports on HP 3PAR StoreServ 10000 and HP 3PAR StoreServ 7000 arrays require a one time configuration using the `controlport` command. (HP 3PAR T-Class, and F-Class arrays do not support the CNA HBA.)

For Example on a new FCoE config:

```
# showport
N:S:P Mode State ----Node_WWN---- -Port_WWN/HW_Addr- Type Protocol
0:3:1 suspended config_wait - - cna -
0:3:2 suspended config_wait - - cna -
```

```
# showport -i
N:S:P Brand Model Rev Firmware Serial HWType
0:3:1 QLOGIC QLE8242 58 0.0.0.0 PCGLT0ARC1K3U4 CNA
0:3:2 QLOGIC QLE8242 58 0.0.0.0 PCGLT0ARC1K3U4 CNA
```

2. If State=config\_wait or Firmware=0.0.0.0, use the `controlport config fcoe` <n:s:p> command to configure. Use the `showport` and `showport -i` commands to verify the configuration setting.

For example:

```
# controlport config fcoe 0:3:1
# controlport config fcoe 0:3:2
# showport 0:3:1 0:3:2
N:S:P Mode State ----Node_WWN---- -Port_WWN/HW_Addr- Type Protocol Label
Partner FailoverState
0:3:1 target ready 2FF70002AC000121 20310002AC000121 host FCoE -
- -
0:3:2 target ready 2FF70002AC000121 20320002AC000121 free FCoE -
- -
# showport -i 0:3:1 0:3:2
N:S:P Brand Model Rev Firmware Serial HWType
0:3:1 QLOGIC QLE8242 58 4.11.122 PCGLT0ARC1K3U4 CNA
0:3:2 QLOGIC QLE8242 58 4.11.122 PCGLT0ARC1K3U4 CNA
```

3. Check the current settings of the FCoE ports by issuing `showport -fcoe`.

For example:

```
# showport -fcoe
N:S:P ENode_MAC_Address PFC_Mask
0:3:1 00-02-AC-07-01-21 0x08
0:3:2 00-02-AC-06-01-21 0x00
```

---

**NOTE:** If changing the config from iSCSI to FCoE, follow the steps below.

1. Issue the `showport` command.

```
# showport
0:3:1    target    ready    -    000E1E05BEE6 iscsi  iSCSI    -    -    -
0:3:2    target    ready    -    000E1E05BEE2 iscsi  iSCSI    -    -    -
```

2. Turn off the iSCSI ports:

```
# controlport offline 0:3:1
# controlport offline 0:3:2

showport
0:3:1 target offline - 000E1E05BEE2 iscsi iSCSI0:3:2 target offline -
000E1E05BEE2 iscsi iSCSI
```

3. Change the topology to FCoE:

```
# controlport config fcoe 0:3:1
# controlport config fcoe 0:3:2

controlport rst 0:3:1
controlport rst 0:3:2
0:3:1 target offline - 000E1E05BEE2 iscsi iSCSI0:3:2 target offline -
000E1E05BEE2 iscsi iSCSI
showport
0:3:1    target    ready 2FF70002AC000121    20310002AC000121  host      FCoE
-        -        -
0:3:2    target    ready 2FF70002AC000121    20320002AC000121  free      FCoE
-        -        -
```

4. Check the current settings of the FCoE ports by issuing `showport -fcoe`.  
For example:

```
# showport -fcoe
N:S:P ENode_MAC_Address PFC_Mask
0:3:1 00-02-AC-07-01-21    0x08
0:3:2 00-02-AC-06-01-21    0x00
```

## Target Port Limits and Specifications

To avoid overwhelming a target port and ensure continuous I/O operations, observe the following limitations on a target port:

- I/O queue depth on each HP 3PAR StoreServ Storage HBA model, as follows:
  - QLogic CNA: 1748 (HP 3PAR StoreServ 10000 and HP 3PAR StoreServ 7000 systems only)
- The I/O queues are shared among the connected host HBA ports on a first-come, first-served basis.
- When all queues are in use and a host HBA port tries to initiate I/O, it receives a target queue full response from the HP 3PAR StoreServ Storage port. This condition can result in erratic I/O performance on each host. If this condition occurs, each host server should be throttled so that it cannot overrun the HP 3PAR StoreServ Storage port's queues when all hosts are delivering their maximum number of I/O requests.

---

**NOTE:** When host ports can access multiple targets on fabric zones, the assigned target number assigned by the host driver for each discovered target can change when the host is booted and some targets are not present in the zone. This situation may change the device node access point for devices during a host reboot. This issue can occur with any fabric-connected storage, and is not specific to the HP 3PAR StoreServ Storage.

---

## HP 3PAR Priority Optimization

The HP 3PAR Priority Optimization feature introduced in HP 3PAR OS 3.1.2. MU2 is a more efficient and dynamic solution for managing server workloads and can be utilized as an alternative to setting host I/O throttles. Using this feature, a storage administrator is able to share storage resources more effectively by enforcing quality of service limits on the array. No special settings are needed on the host side to obtain the benefit of HP 3PAR Priority Optimization although certain per target or per adapter throttle settings may need to be adjusted in rare cases. For complete details of how to use HP 3PAR Priority Optimization (Quality of Service) on HP 3PAR StoreServ Storage arrays, see the *HP 3PAR Priority Optimization* technical white paper available at the following website:

[HP 3PAR Priority Optimization](#)

## HP 3PAR OS Persistent Ports

The HP 3PAR OS Persistent Ports (or virtual ports) feature minimizes I/O disruption during an HP 3PAR StoreServ Storage online upgrade or node-down event (online upgrade, node reboot, or cable pull test). Port shutdown or reset events do not trigger this feature.

Each FCoE target storage array port has a partner array port automatically assigned by the system. Partner ports are assigned across array node pairs.

HP 3PAR OS Persistent Ports allows an HP 3PAR StoreServ Storage FCoE port to assume the identity (port IP address) of a failed port while retaining its own identity. Where a given physical port assumes the identity of its partner port, the assumed port is designated as a persistent port. Array port failover and failback with HP 3PAR OS Persistent Ports is transparent to most host-based multipathing software, which can keep all of its I/O paths active.

---

**NOTE:** Use of HP 3PAR OS Persistent Ports technology does not negate the need for properly installed, configured, and maintained host multipathing software.

---

For a more complete description of the HP 3PAR OS Persistent Ports feature, its operation, and a complete list of required setup and connectivity guidelines, see:

- the HP Technical white paper *HP 3PAR StoreServ Persistent Ports* (HP document #F4AA4-4545ENW)

This document is available on the following HP SC website:

[HP Support Center](#)

- the *HP 3PAR Command Line Interface Administrator's Manual*, "Using Persistent Ports for Nondisruptive Online Software Upgrades"

This document is available on the following HP SC website:

[HP Support Center](#)

## Fibre Channel over Ethernet

---

**NOTE:** For information regarding the Persistent Ports feature for an FCoE initiator to FC target configuration (FCoE to FC switched), see "[Configuring the HP 3PAR StoreServ Storage for Fibre Channel](#)" (page 9).

---

### HP 3PAR OS Persistent Ports Setup and Connectivity Guidelines for FCoE

Starting with HP 3PAR OS 3.1.3, the HP 3PAR OS Persistent Ports feature is supported for FCoE target ports (FCoE end-to-end configurations).

Starting with HP 3PAR OS 3.1.3 software and above, the HP 3PAR OS Persistent Ports feature is enabled by default for HP 3PAR StoreServ Storage FCoE ports during node-down events.

Specific cabling setup and connectivity guidelines need to be followed for HP 3PAR OS Persistent Ports to function properly. Key elements for the HP 3PAR OS Persistent Ports feature setup and connectivity are:

- HP 3PAR StoreServ Storage FCoE partner ports must be connected to the same FCoE network.
- The same CNA port on host-facing HBAs in the nodes of a node pair must be connected to the same FCoE network, and preferably to different FCoE switches on the network.
- The FCoE network being used must support NPIV, and NPIV must be enabled.

## 5 Configuring a Host with Fibre Channel

This chapter describes the tasks necessary for connecting the host to Fibre Channel.

**NOTE:** For RHEL 6.x, follow the instructions for RHEL 5.x, unless otherwise noted. When tasks are specific to the version of the RHEL OS, headings refer to RHEL 4, RHEL 5, or RHEL 6.

### Checking the Host for Required Packages

If you are installing and building the Emulex driver, make sure the Developmental Tool package that contains the gcc compiler is installed on the RHEL server. If not, install them from the RHEL installation CD. After installation, verify the following gcc packages were installed. Some gcc packages may not be needed.

The following example shows gcc compilers installed for RHEL 4 Update 6 Linux.

```
# rpm -qa | grep gcc
gcc-java-3.4.6-9
gcc-3.4.6-9
compat-gcc-32-c++-3.2.3-47.3
gcc-c++-3.4.6-9
compat-libgcc-296-2.96-132.7.2
libgcc-3.4.6-9
gcc-g77-3.4.6-9
libgcc-3.4.6-9
```

### Installing the Emulex HBA

Install the Emulex host bus adapter(s) or converged network adapter(s) (CNAs) in the host in accordance with the documentation provided with the HBAs or CNAs and host.

### Building the Emulex Driver

**NOTE:** HP recommends using the Emulex driver, which can be downloaded from the HP Support website:

[HP Support](#)

(Optional) Use this section only if you are installing and building the Emulex driver from the Emulex website.

If you are using the Emulex driver that was installed by the RHEL installation, skip to “[Modifying the /etc/modprobe.conf File and Building the Ramdisk](#)” (page 33).

If you are installing the Emulex driver instead of using the in-box Emulex driver that was already installed by the RHEL installation, follow these steps:

1. Download the driver package from the Emulex website:  
[Emulex](#)
2. Extract the driver contents by issuing `tar xvzf lpfc_<kernel version>_driver_kit-<version>.tar.gz`

For example:

```
# tar xvzf lpfc_2.6_driver_kit-8.2.0.29-1.tar.gz
lpfc_2.6_driver_kit-8.2.0.29-1/
lpfc_2.6_driver_kit-8.2.0.29-1/lpfcdriver_2.6-8.2.0.29-1.noarch.rpm
lpfc_2.6_driver_kit-8.2.0.29-1/lpfc-install
lpfc_2.6_driver_kit-8.2.0.29-1/README
```



3. Change to the driver source directory by issuing `cd lpfc_<kernel version>_driver_kit-<version>`. For example:

```
# cd lpfc_2.6_driver_kit-8.2.0.29-1
```

4. Run the `lpfc-install` script that builds and installs the `lpfc` driver. Check the installed README for more details.

```
# ./lpfc-install
```

The script performs the following:

- a. The driver source is installed at `/usr/src/lpfc` from the installed rpm packages `lpfcdriver-<kernel version>_<driver version>`. For example:

```
# ls /usr/src/lpfc/lpfcdriver*
lpfcdriver-2.6-8.0.16.40-2
```

- b. The `lpfc` driver parameters are added to `/etc/modprobe.conf`.
- c. The newly built Emulex driver `lpfc.ko` is copied to `/lib/modules/<uname -r>/kernel/drivers/scsi/lpfc`. The current `lpfc` driver is saved at `/usr/src/lpfc/savedfiles`.
- d. A new ramdisk is created and the currently running ramdisk is copied as `/boot/initrd-<uname -r>.img`.

**⚠ CAUTION:** The new ramdisk is always created with the name `initrd-<uname -r>.img`. Edit the boot loader to add the correct ramdisk name.

Example: For kernel `<uname -r>=2.6.18-53.el5`, the ramdisk created by the script will be `initrd.2.6.18-53.el5.img`.

**NOTE:** You can change Emulex driver parameters by modifying the `/etc/modprobe.conf.local` configuration file that enables these driver parameter values when the drivers are loaded during bootup. Only the parameters required for use with the HP 3PAR StoreServ Storage are discussed here.

The items in bold were added by the `lpfc-install` script to the `/etc/modprobe.conf` configuration file for a dual ported HBA:

```
# cat /etc/modprobe.conf
alias eth0 e1000
alias eth1 e1000
alias scsi_hostadapter mptbase
alias scsi_hostadapter1 mptscsih
alias usb-controller ehci-hcd
alias usb-controller1 uhci-hcd
alias scsi_hostadapter2 lpfc
alias scsi_hostadapter3 lpfc
```

## Modifying the `/etc/modprobe.conf` File and Building the Ramdisk

This section describes how to modify the `/etc/modprobe.conf` file to set Emulex HBA parameters and build the ramdisk.

1. Before building the ramdisk, add the following HBA parameters to the `/etc/modprobe.conf` file, depending on your version of RHEL. These HBA options settings are required for desired multipath failover/failback operation:

- For RHEL 6:

**NOTE:** The `/etc/modprobe.conf` file has been deprecated in RHEL 6. In order to make changes to the ramdisk, follow these steps:

1. Create the `/etc/modprobe.d/modprobe.conf` file.
2. If the HP 3PAR array is running HP 3PAR OS 3.1.1 or later, add the following line:

```
options lpfc lpfc_devloss_tmo=14 lpfc_lun_queue_depth=16
lpfc_discovery_threads=32
```

- For RHEL 5:

```
options lpfc lpfc_devloss_tmo=14 lpfc_lun_queue_depth=16
lpfc_discovery_threads=32
```

- For RHEL 4:

```
options lpfc lpfc_nodev_tmo=14 lpfc_lun_queue_depth=16
lpfc_discovery_threads=32
```

**NOTE:** If the HP 3PAR array is running an HP 3PAR OS version earlier than 3.1.1, set the `lpfc_devloss_tmo` or `lpfc_nodev_tmo` setting to 1 instead of 14 for the corresponding RHEL version.

2. To increase or modify maximum number of LUNs the OS can discover, add SCSI layer parameters to `/etc/modprobe.conf`.

**NOTE:** RHEL 6.x does not require this change. The `/etc/modprobe.conf` file has been deprecated in RHEL 6.

For example, for the OS to support 256 LUNs per target port:

```
options scsi_mod max_luns=256
```

**NOTE:** The kernel loads the SCSI drivers from ramdisk in the order in which they are defined in the `modprobe.conf` file and assigns the SCSI device entries (`sda`, `sdb`) in ascending order starting with the first entry for each entry where a SCSI device exists. If the host has a SCSI boot disk, it must obtain device entry `sda` since those entries are hard coded in the bootloaders. Therefore, the `scsi_hostadapter` entry that supports the boot disk must appear first in the `/etc/modprobe.conf` file.

3. Change the `/etc/modprobe.conf` file after making the driver topology changes.  
The following example is for an RHEL 6.x or RHEL 5.x connected to an HP 3PAR StoreServ Storage array running HP 3PAR OS 3.1.1 or later. If the HP 3PAR StoreServ Storage array

is running an older HP 3PAR OS version (one that is not HP 3PAR OS 3.1.1 or later), set the `lpfc_devloss_tmo` setting to 1.

```
# cat /etc/modprobe.conf
alias eth0 e1000
alias eth1 e1000
alias scsi_hostadapter mptbase
alias scsi_hostadapter1 mptscsih
alias usb-controller ehci-hcd
alias usb-controller1 uhci-hcd
alias scsi_hostadapter2 lpfc
alias scsi_hostadapter3 lpfc
options lpfc lpfc_devloss_tmo=14 lpfc_lun_queue_depth=16
lpfc_discovery_threads=32
options scsi_mod max_luns=256
```

If a zoning-by-HBA configuration is used, where an HP 3PAR StoreServ Storage port is connected to many hosts through a fabric, it is possible that the target port will run out of I/O buffers and will result in the target port issuing a QUEUE FULL SCSI status message to any new incoming I/O requests from any other hosts on that port. To prevent this event, you can throttle the host port queue depth and LUN queue depth. For the Emulex driver, the port queue depth is defined by driver parameter `lpfc_hba_queue_depth`, and the LUN queue depth by `lpfc_lun_queue_depth`. Change the default values if any throttling is required.

### Required

Storage administrators should carefully consider the number of hosts connected to an HP 3PAR StoreServ Storage port and the number of LUN exports for calculating the throttling configuration values. Performance degradation and SCSI timeout issues will result if the values are set too high.

See the following white paper for a description of calculating queue depth and monitoring port queues:

[Host I/O Queues and HP 3PAR StoreServ Storage](#)

**NOTE:** The ramdisk image needs to be rebuilt for any changes made to `/etc/modprobe.conf` to be effective. The system will pick up the ramdisk changes on bootup.

#### 4. Rebuild the ramdisk image.

- For RHEL 4 or RHEL 5, rebuild the ramdisk image using the `mkinitrd` command:

```
# /sbin/mkinitrd -v -f /boot/<ramdisk image name> <kernel-version>
```

- For Oracle UEK 5.7, add the following options to the `mkinitrd` command to rebuild the kernel:

```
# /sbin/mkinitrd --builtin=ehci-hcd --builtin=ohci-hcd --builtin=uhci-hcd
-f -v /boot/initrd-2.6.32-200.13.1.el5uek.img 2.6.32-200.13.1.el5uek
```

- For RHEL 6, rebuild the ramdisk image using the `dracut` command:

```
# /sbin/dracut -v -f /boot/<ramdisk image name> <kernel-version>
```

The following example shows a ramdisk build:

```
# /sbin/dracut -v -f /boot/initrd-2.6.18-53.el5.img 2.6.18-53.el5
Creating initramfs
Looking for deps of module scsi_mod
Looking for deps of module sd_mod scsi_mod
Looking for deps of module scsi_transport_spi: scsi_mod
. . .
copy from `/lib/modules/2.6.18-8.el5/kernel/drivers/scsi/scsi_transport_fc.ko'
[elf64-x86-64] to `/tmp/initrd.113681/lib/scsi_transport_fc.ko' [elf64-x86-64]
copy from `/lib/modules/2.6.18-8.el5/kernel/drivers/scsi/lpfc/lpfc.ko' [elf64-
x86-64] to `/tmp/initrd.113681/lib/lpfc.ko' [elf64-x86-64]
. . .
Loading module jbd
Loading module ext3
Loading module scsi_mod
Loading module scsi_mod with options max_luns=256
Loading module sd_mod
Loading module mptbase
Loading module mptscsih
Loading module scsi_transport_fc
Loading module lpfc with options lpfc_topology=0x02 lpfc_devloss_tmo=14
lpfc_lun_queue_depth=16 lpfc_discovery_threads=32
```

5. Reboot the host:

```
# reboot
```

6. When the host comes back up after a reboot, verify that the Emulex HBA driver parameter changes have taken effect. Use one of the following commands for lpfc. Be sure to check both locations, because some parameters are in both locations, but some are in only one. For example:

```
# cat /sys/module/lpfc/parameters/lpfc_devloss_tmo
14

# cat /sys/class/scsi_host/host4/lpfc_devloss_tmo
14

# cat /sys/module/lpfc/parameters/lpfc_discovery_threads
32
```

7. Check the contents of the `/etc/grub.conf` or `/boot/grub/grub.conf` with grub as the bootloader so that the `initrd` maps to the correct ramdisk image.

```
# vi /etc/grub.conf
default=<label number>
timeout=5
...
hiddenmenu
title RedHat Enterprise Linux Server (2.6.18-8.el5)
root (hd0,2)
kernel /boot/vmlinuz-2.6.18-8.el5 ro root=LABEL=/ rhgb quiet
initrd /boot/initrd-2.6.18-8.el5.img
...
```

## Setting up the NVRAM and BIOS with the Emulex HBA

This section describes setting up the NVRAM and BIOS with the Emulex HBA.

Configure the following NVRAM settings using the Emulex Lightpulse BIOS utility. Access the BIOS utility by hard booting the server and, when prompted, perform the procedures in this section.

---

**NOTE:** The NVRAM settings on Emulex HBAs can be changed by any server in which they are installed. These settings will persist for an HBA even after it is removed from a server.

---

### Enabling an Adapter to Boot from SAN

1. To start the BIOS utility, turn on the computer, hold down the **Alt** or **Ctrl** key, and press **E** within five seconds to display the bootup message.

The adapter listing is displayed.

---

**NOTE:** Each HBA port is reported as a host bus adapter. The following settings need to be applied for each HBA port.

---

2. Select a host adapter from the main menu.
3. From the **Main** configuration menu, select **Enable/Disable Boot from SAN**.

Adapters are disabled by default. At least one adapter must be enabled to boot from SAN in order to use remote boot functionality.

### Configuring Boot Devices

---

**NOTE:** If it is necessary to change the topology, do so before you configure the boot devices. The default topology is auto topology with loop first.

---

1. On the main configuration menu select **Configure Boot Devices**.  
A list of eight boot devices is shown.
2. Select a boot entry.
3. Select **<00>** to clear the selected boot entry, or select a device to configure booting by.
4. If you select a device, enter the starting LUN. The starting LUN can be any number from 0 to 255.

---

**NOTE:** You can define 256 LUNs per adapter, but the screen displays only 16 consecutive LUNs at a time. In front of each entry, B#D or B#W specifies the boot entry number and whether the device boots by DID or WWPN. For example, B1D means that boot entry 1 boots from the DID. B2W means that boot entry 2 boots from WWPN.

---

5. Type the two digits corresponding to the entry you are selecting.
6. Select the boot method you want. If you select to boot the device by WWPN, the WWPN of the earlier selected entry is saved in the flash memory. If you select to boot this device by DID, the earlier selected entry is saved in the flash memory.
7. Press the **Esc** key until you exit the BIOS utility.
8. Reboot the system for the new boot path to take effect.

Refer to the *Emulex Boot Code User Manual* for more detail and additional options.

### Configuring the Emulex HBA using the HBACMD Utility

This section describes how to configure the Emulex HBA using the HBACMD utility.

Emulex provides a CLI utility (OneCommand) to configure their HBAs. This is also available as a GUI. These tools, once installed, can be used to configure many HBA and driver parameters.

To configure many of these parameters you must identify the HBA to work on using its WWPN. These can be obtained by using the following command:

```
# hbacmd ListHBAs
```

This will produce output similar to the following:

```
Manageable HBA List

Port WWN      : 10:00:00:00:c9:69:d6:cc
Node WWN      : 20:00:00:00:c9:69:d6:cc
Fabric Name   : 00:00:00:00:00:00:00:00
Flags         : 8000fe0d
Host Name     : dl360g7-16.3pardata.com
Mfg           : Emulex Corporation
Serial No.    : VM72838048
Port Number   : 0
Mode          : Initiator
PCI Function  : 0
Port Type     : FC
Model         : LPe11002-M4

Port WWN      : 10:00:00:00:c9:69:d6:cd
Node WWN      : 20:00:00:00:c9:69:d6:cd
Fabric Name   : 00:00:00:00:00:00:00:00
Flags         : 8000fe0d
Host Name     : dl360g7-16.3pardata.com
Mfg           : Emulex Corporation
Serial No.    : VM72838048
Port Number   : 1
Mode          : Initiator
PCI Function  : 1
Port Type     : FC
Model         : LPe11002-M4
```

For example, to enable the adapter BIOS, type:

```
# hbacmd EnableBootCode <WWPN>
```

For full instructions about using the HBACMD utility and all its features, see the Emulex *OneCommand Manager Command Line Interface User Manual*, available on the Emulex website:

[Emulex](#)

## Installing the QLogic HBA

Install the QLogic HBA(s) in the host in accordance with the documentation provided with the HBAs and host.

## Building the QLogic Driver

**NOTE:** If you are using the in-box QLogic driver by the RHEL host installation, skip this section and go to “[Modifying the /etc/modprobe.conf file and Building the Ramdisk](#)” (page 39).

If you are building the QLogic driver, follow these steps:

1. Download the driver package (SANsurfer Linux Installer for RHEL kernel) from [www.qlogic.com](http://www.qlogic.com) and extract the driver contents.
2. Follow the provided README to build the driver.

## Modifying the /etc/modprobe.conf file and Building the Ramdisk

**NOTE:** The /etc/modprobe.conf file has been deprecated in RHEL 6. In order to make changes to the ramdisk, create the /etc/modprobe.d/modprobe.conf file.

1. If the HP 3PAR array is running HP 3PAR OS 3.1.1 or later, modify the options qla2xxx line to include qlport\_down\_retry=10, as shown below.

The modified output of /etc/modprobe.conf should include the following when the 3PAR array is running HP 3PAR OS 3.1.1 or later:

**NOTE:** If the HP 3PAR array is running an HP 3PAR OS version earlier than OS 3.1.1, set the qlport\_down\_retry setting to 1 rather than 10.

```
# cat /etc/modprobe.conf
alias scsi_hostadapter1 qla2xxx
options scsi_mod max_luns=256
options qla2xxx ql2xmaxqdepth=16 qlport_down_retry=10 ql2xloginretrycount=30
```

If a fan-out configuration is used, where an HP 3PAR StoreServ Storage port is connected to many hosts through the fabric, it is possible that the target port will run out of I/O buffers and will result in the target port issuing a QUEUE FULL SCSI status message to any new incoming I/O requests from any host on that port. To prevent this event, you can throttle the host Port Queue depth and LUN Queue depth. By default, the QLogic driver sets Port Queue depth (Execution Throttle) to FFFF (65535) (overriding the default BIOS execution value of 32) and sets the LUN Queue Depth to 32 (default). You can throttle the LUN Queue depth value to a lower value using the ql2xmaxqdepth parameter. QLogic does not offer any driver setting to change the Port Queue depth or Execution Throttle. Change the default values if any throttling is required.

In the following example, the output shows the /etc/modprobe.conf when the ql2xmaxqdepth is set to 16 for an RHEL server that is connected to an HP 3PAR array that is running HP 3PAR OS 3.1.1 or later.

```
# cat /etc/modprobe.conf
alias scsi_hostadapter1 qla2xxx
alias scsi_hostadapter2 qla2300
alias scsi_hostadapter3 qla2322
alias scsi_hostadapter4 qla2400
alias scsi_hostadapter5 qla6312
options scsi_mod max_luns=256
options qla2xxx qlport_down_retry=10 ql2xloginretrycount=30 ql2xmaxqdepth=16
ConfigRequired=0
install qla2xxx /sbin/modprobe --ignore-install qla2xxx
remove qla2xxx /sbin/modprobe -r --first-time --ignore-remove qla2xxx
```

### Required

Storage administrators should carefully consider the number of hosts connected to an HP 3PAR StoreServ Storage port and the number of LUN exports for calculating the throttling configuration values. Performance degradation and SCSI timeout issues will result if the values are set too low.

2. Rebuild the ramdisk image after the /etc/modprobe.conf file entries are modified.
3. To make the changes, you can issue the mkinitrd command or use the QLogic driver script.

```
# mkinitrd -f -v /boot/initrd-<uname -r>.img <uname -r>
```

For example:

```
# mkinitrd -f -v /boot/initrd-2.6.18-53.el5.img 2.6.18-53.el5
```

**NOTE:** For RHEL 6, rebuild the ramdisk image using the `dracut` command:

```
# /sbin/dracut -v -f /boot/<ramdisk image name> <kernel-version>
```

4. Perform one of the two following actions to verify that all the required drivers are added to the ramdisk image:

- Check the verbose output. For example:

```
Creating initramfs
. . . .
. . . .
Looking for deps of module scsi_mod
Looking for deps of module sd_mod: scsi_mod
. . . .
. . . .
Looking for deps of module qla2xxx: intermodule scsi_mod
Looking for deps of module intermodule
. . . .
. . . .
```

- Check the contents of the `/etc/grub.conf` or `/boot/grub/grub.conf` with `grub` as the bootloader so that the `initrd` maps to the correct ramdisk image.

```
# vi /etc/grub.conf
default=<label number>
timeout=5
...
hiddenmenu
title RedHat Enterprise Linux Server (kernel name)
root (hd0,0)
kernel /<kernel name> ro root=LABEL=/ rhgb quiet
initrd /<RamDisImage>
```

## Setting Up the NVRAM and BIOS with the QLogic HBA

This section describes how to set up the NVRAM and BIOS with the QLogic HBA.

Configure the following NVRAM settings for QLogic 23xx, 24xx and 25xx cards using the QLogic Fast!UTIL. Access the Fast!UTIL utility by hard booting the server and, when prompted and follow these steps:

**NOTE:** The NVRAM settings on QLogic HBAs can be changed by any server in which they are installed. These settings will persist for an HBA even after it is removed from a server. To obtain the correct settings for this configuration, you will be instructed to return all NVRAM settings to their default settings.

1. Enter Fast!UTIL by pressing **Ctrl-Q** when prompted.

**NOTE:** Each HBA port is reported as a host bus adapter and the following settings need to be made for each of them.



2. Select a host adapter from the main menu.
3. Restore the default settings of the HBA as follows: **Configuration Settings→Restore Default Settings**.
4. Make the following setting changes:

**NOTE:** The parameters provided in these menu options might vary between different QLogic HBA models, and may not appear as shown here.

- **Configuration Settings→Advanced Adapter Settings→Execution Throttle: 256**
- **Configuration Settings→Advanced Adapter Settings→LUNs per Target: 256**
- **Configuration Settings→Extended Firmware Settings→Data Rate: 2 (AutoNegotiate)**

5. Specify the connection option.

**NOTE:** The BIOS menus, which vary by adapter model and the BIOS version installed, might not appear as shown here. See the documentation for your adapter."

- Specify loop topology for direct-connect configurations: **Configuration Settings→Extended Firmware Settings→Connection Options: 0 (Loop Only)**
- Specify point-to-point topology for fabric configurations: **Configuration Settings→Extended Firmware Settings→Connection Options: 1 (Point to Point Only)**

6. Repeat for each port listed as a separate HBA port.

## Configuring the QLogic HBA Using the SCLI Utility

This section describes how to configure QLogic HBA settings using the SCLI utility.

**⚠ CAUTION:** If you are running the QLogic inbox driver, ensure that only the utility tool is installed. The preferred method will be to use the Fast!Util HBA, as the QLogic tool may not be compatible with all inbox drivers.

**NOTE:** For Itanium servers, this is the only method available. For other Intel platform servers, either use the SCLI utility or the Fast!Util HBA BIOS method.

In order to make topology changes to the QLogic cards in the Intel Itanium server which have the Extensible Firmware Interface (EFI) as the system firmware (BIOS), use the QLogic SANsurfer FC CLI utility. You can download the latest version of the SCLI utility from the QLogic website or use the version that is installed as part of the driver package installation.

Once you install the QLogic SANsurfer FC CLI utility for each of the HBA ports, set the correct port connection type (direct → loop, fabric → point) by running the following commands:

- For fabric connection:

```
# /opt/QLogic_Corporation/SANsurferCLI/scli -n X CO 1
```

- For direct connection:

```
# /opt/QLogic_Corporation/SANsurferCLI/scli -n X CO 0
```

where **X** is equal to the HBA FC port #, the HBA port numbers start with number **0**.

For example, to set the HBA ports 1 and 3 to **Point to Point/Fabric** topology, run the following commands:

```
# /opt/Qlogic_Corporation/SANsurferCLI/scli -n 1 CO 1
# /opt/Qlogic_Corporation/SANsurferCLI/scli -n 3 CO 1
```

To set the same HBA ports 1 and 3 to **Direct** topology, run the following commands:

```
# /opt/Qlogic_Corporation/SANsurferCLI/scli -n 1 CO 0
# /opt/Qlogic_Corporation/SANsurferCLI/scli -n 3 CO 0
```

You can verify the setting by running the following command:

```
# /opt/Qlogic_Corporation/SANsurferCLI/scli -I 1
# /opt/Qlogic_Corporation/SANsurferCLI/scli -I 3
```

Refer to the SANsurfer FC CLI utility program release notice for other command line options to change the following settings:

- LUNs per Target: 256
- Data Rate: 4 (Auto Negotiate)

## Installing the Brocade HBA

Install the Brocade host bus adapter(s) (HBAs) in the host in accordance with the documentation provided with the HBAs and host.

## Building the Brocade Driver

**NOTE:** Use this section only if you are installing and building the Brocade driver. If you are using the Brocade driver that was installed by the RHEL installation, skip to [“Setting up the NVRAM and BIOS with the Brocade HBA” \(page 43\)](#).

If you are installing the Brocade driver instead of using the in-box Brocade driver that was already installed by the RHEL installation, follow these steps:

1. Download the driver package from the following website:

[Brocade](#)

Extract the driver contents by issuing `tar xvzf brocade_driver_linux-<version>.tar.gz`. Make sure to do this in a temporary location. For example:

```
# tar zxvf brocade_driver_linux_rhel6_v3-2-1-0.tar.gz
bfa_driver_linux-3.2.1.0-0.noarch.rpm
bfa_util_linux_noioctl-3.2.1.0-0.noarch.rpm
bna_driver_linux-3.2.1.0-0.noarch.rpm
bna-snmp-3.2.1.0-rhel6.i386.rpm
bna-snmp-3.2.1.0-rhel6.x86_64.rpm
brocade_install_rhel.sh
brocade_install.sh
driver-bld-info.xml
RHEL60/
RHEL61/
RHEL62/
RHEL62/kmod-bna-3.2.1.0-0.el6.x86_64.rpm
RHEL62/kmod-bfa-3.2.1.0-0.el6.i686.rpm
RHEL62/kmod-bfa-3.2.1.0-0.el6.ppc64.rpm
RHEL62/kmod-bna-3.2.1.0-0.el6.i686.rpm
RHEL62/kmod-bna-3.2.1.0-0.el6.ppc64.rpm
RHEL62/kmod-bfa-3.2.1.0-0.el6.x86_64.rpm
RHEL63/
RHEL63/kmod-bna-3.2.1.0-0.el6.x86_64.rpm
RHEL63/kmod-bfa-3.2.1.0-0.el6.i686.rpm
RHEL63/kmod-bna-3.2.1.0-0.el6.i686.rpm
RHEL63/kmod-bfa-3.2.1.0-0.el6.x86_64.rpm
RHEL64/
RHEL64/kmod-bna-3.2.1.0-0.el6.x86_64.rpm
RHEL64/kmod-bfa-3.2.1.0-0.el6.i686.rpm
RHEL64/kmod-bna-3.2.1.0-0.el6.i686.rpm
RHEL64/kmod-bfa-3.2.1.0-0.el6.x86_64.rpm.sh
```

2. Run the `brocade_install.sh` script that installs the bfa driver and associated utilities:

```
# ./brocade_install.sh
Installing the Brocade driver 3.2.1.0 RPM's
initrd backup complete
Backup file name : initramfs-2.6.32-279.el6.x86_64.img.bak
Installing the BFA driver RPM: bfa_driver_linux-3.2.1.0-0.noarch.rpm
Preparing... ##### [100%]
1:bfa_driver_linux ##### [100%]
   Building bfa driver ..... done
   initrd update .... done
   Installing the util driver RPM
   Preparing... #####
[100%]
1:bfa_util_linux_noioctl ##### [100%]
   Install cli ... done
   Install HBAAPI library ... done
   Install HBAAGENT ... done
   Loading bfa driver ... done
   initrd update .... done
```

## Setting up the NVRAM and BIOS with the Brocade HBA

This section describes setting up the NVRAM and BIOS with the Brocade HBA.

## Configure the following NVRAM settings using the Brocade BIOS utility

Access the BIOS utility by hard booting the server and, when prompted, perform the procedures in this section.

---

**NOTE:** The NVRAM settings on Brocade HBAs can be changed by any server in which they are installed. These settings will persist for an HBA even after it is removed from a server.

---

### Enabling an Adapter to Boot from SAN

To start the BIOS utility, turn on the computer, hold down the **Alt** or **Ctrl** key, and press **B** within five seconds to display the bootup message. The adapter listing is displayed.

---

**NOTE:** Each HBA port is reported as a host bus adapter. The following settings need to be applied for each HBA port.

---

1. Proceed into the **Adapter Settings** and ensure BIOS is set to **Enabled**.
2. Press **Alt-S** to save and exit this section.
3. If you need to configure boot devices or another adapter choose **Return to Brocade Config Menu** otherwise choose **Exit Brocade Config Menu**.

### Configuring Boot Devices

---

**NOTE:** If it is necessary to change the topology, do so before you configure the boot devices.

---

1. Proceed into the **Boot Device Settings**.
2. Select the **Boot Device** you wish to change and press **ENTER**.
3. Select the new **Boot Target** and press **ENTER**.
4. Select the **Boot LUN** and press **ENTER**.
5. Repeat steps 2, 3 and 4 for any additional **Boot Devices**.
6. Press **Alt-S** to save your changes.
7. If you need to configure more boot devices or another adapter choose **Return to Brocade Config Menu**, otherwise choose **Exit Brocade Config Menu**.

### Configuring the Brocade HBA using the BCU Utility

This section describes how to configure the Brocade HBA using the BCU utility.

Brocade provides a CLI utility to configure their HBAs. This is also available as a GUI. These tools, once installed, can be used to configure many HBA and driver parameters.

For instructions about using the BCU CLI and GUI utilities, see the documentation at the following website:

[Brocade](#)

For Brocade FC HBA, the default `Path TOV` parameter is set to 30 seconds. It is recommended to change this value to 14 seconds. To change the value of this parameter, it is required to use Brocade BCU command line utility. For example:

1. This is a per-port setting. List the available ports by issuing the `bcu port --list` command:

```
# bcu port --list
-----
Port#  FN Type PWWN/MAC FC Addr/ Media State Spd
      Eth dev
-----
1/0 -  fc 10:00:8c:7c:ff:30:41:60 036100 sw Linkup 4G
    0  fc 10:00:8c:7c:ff:30:41:60 036100 sw Linkup 4G
1/1 -  fc 10:00:8c:7c:ff:30:41:61 036000 sw Linkup 4G
    1  fc 10:00:8c:7c:ff:30:41:61 036000 sw Linkup 4G
-----
```

2. Set the `path_tov` value for each port by issuing the `bcu fcpim --pathtov <pcifn> <to>` command:

```
# bcu fcpim --pathtov 1/0 14
path timeout is set to 14
```

## Setting the SCSI Timeout

The SCSI timeout needs to be set in order for the HP 3PAR StoreServ Storage to operate properly with RHEL servers. Use the following guidelines depending on your version of RHEL:

- RHEL 6: The SCSI timeout value is already set to the default value of 30 seconds and does *not* need to be changed.
- RHEL 5: The SCSI timeout value is already set to the default value of 60 seconds and does *not* need to be changed.
- RHEL 4: The SCSI timeout value is 30 seconds and needs to be changed to 60 seconds.



**WARNING!** For RHEL 4 and RHEL 5 only: If not set to 60 seconds, the SCSI timeout will result in host disks being taken offline during HP 3PAR StoreServ Storage rolling upgrades. Furthermore, Remote Copy requires the SCSI timeout value of 60 seconds, otherwise remote copy operations will become stale with a node reboot.

## Using UDEV Rules to Set the SCSI Timeout

For RHEL 4 configurations, change the timeout from 30 seconds to 60 seconds using the `udev` rules or a SCSI timeout script so that the change will be effective only for HP 3PAR devices. The `udev` rule method is preferable since it changes the SCSI timeout value dynamically whenever a SCSI device instance is created (for example: `/dev/sda`).

If using the timeout script, then run the script manually whenever device instances are created and the timeout value is lost on reboot or driver reload.

**NOTE:** The `udev` rules method has been tested on RHEL Update 5. For RHEL 6, use the default setting (no modification is required). For RHEL 4 Update 4 and below, check and verify that the `udev` rule method works. If it does not work, then use the `ql_ch_scsi_timeout` script method in [“Using QLogic Scripts to Set the SCSI Timeout” \(page 47\)](#) to change the SCSI timeout value.

1. Make sure the `udev` package is installed on your server. If not, install it from the RHEL CD. For example:

```
# rpm -qa | grep udev
udev-039-10.19.el4.x86_64.rpm
```

2. Create udev rules `56_3par_timeout.rules` under `/etc/udev/rules.d` with the following contents:

```
/etc/udev/rules.d/56-3par.timeout.rules
```

```
KERNEL="sd* [!0-9]", SYSFS{vendor}="3PARdata", PROGRAM="/bin/sh -c 'echo 60 > /sys/block/%k/device/timeout'" NAME="%k"
```

### Required

Make sure there is no break between the two lines in the `56-3par-timeout.rules`.

The udev rule number `56-3par-timeout.rules` should follow after the `51-by-id.rules`. Change the udev rule number accordingly.

The `56-3par-timeout.rules` is selected based on the test system configuration. See [“Using UDEV Rules to Set the SCSI Timeout” \(page 45\)](#) to verify that the `56-3par-timeout.rules` udev rule is working.

```
# ls /etc/udev/rules.d/
. . . . .
40-multipath.rules
50-udev.rules
51-by-id.rules
56-3par-timeout.rules
```

## Verifying the SCSI Timeout Settings

Verify the udev rules setting after the HP PAR storage volumes have been exported to the host. For details, see [“Allocating Storage for Access by the RHEL Host” \(page 103\)](#).

```
# udevinfo -a -p /sys/block/sdx
```

For example:

```
# udevinfo -a -p /sys/block/sdn |grep timeout
SYSFS{timeout}="60"
```

On RHEL 6, you can also verify the SCSI timeout settings as follows:

```
cat /sys/class/scsi_device/*/device/timeout
```

On RHEL 5 using Emulex HBAs, verify using the following:

```
/sys/class/scsi_device/*/device/timeout
```

If the udev rule is created after the host sees HP 3PAR StoreServ Storage volumes, execute the `udevstart` command, which runs the udev rules on all devices and sets the timeout to 60. The time it takes for the `udevstart` command to complete is based on the number of devices and I/O throughput, so the recommendation is to run the command during non-peak activity.

```
# udevstart
```

Rebooting the host starts the udev rule by default.

## Using QLogic Scripts to Set the SCSI Timeout

The following script changes the SCSI timeout value to 60 seconds for LUNs discovered by each of the QLogic HBA ports. Use this script if you are running Remote Copy.

If you have implemented the timeout value change using the `udev` method, then do not use this script.

When you run the script, the SCSI timeout value for each of the current LUNs discovered will be changed immediately. However, when rebooting the server, the timeout value will revert to the default value of 30 seconds.

The following example shows the content for Script `ql_ch_scsi_timeout.sh`:

```
qlogicname="/sys/class/scsi_host"
timeout=60
ls $qlogicname | grep "[0-9][0-9]*" | while read line
do
  fname=${qlogicname}/${line}
  curr=`pwd`
  cd $fname
  find . -follow -name "timeout" | grep -v "generic" | while read line2
  do
    vendorcheck=`cat ${line2%timeout}vendor | grep -c "3PARdata"`
    if [ $vendorcheck -gt 0 ] ; then
      echo "modifying file: [$fname$line2]"
      echo "$timeout" > $line2
    fi
  done
cd $curr
done
```

You can have this script run during the OS boot up sequence by adding the contents of the script into the `/etc/rc.local` file. Make sure `/etc/rc.local` file has the permissions values set to 777.

The following example shows the contents of `/etc/rc.local`:

```
# cat /etc/rc.local
#!/bin/sh
#
# This script will be executed *after* all the other init scripts.
# You can put your own initialization stuff in here if you don't
# want to do the full Sys V style init stuff.
touch /var/lock/subsys/local
qlogicname="/sys/class/scsi_host"
timeout=60
ls $qlogicname | grep "[0-9][0-9]*" | while read line
do
  fname=${qlogicname}/${line}
  curr=`pwd`
  cd $fname
  find . -follow -name "timeout" | grep -v "generic" | while read line2
  do
    vendorcheck=`cat ${line2%timeout}vendor | grep -c "3PARdata"`
    if [ $vendorcheck -gt 0 ] ; then
      echo "modifying file: [$fname$line2]"
      echo "$timeout" > $line2
    fi
  done
cd $curr
done
```

## Using Emulex Scripts to Set the SCSI Timeout

If the `udev` rule was not implemented, you can change the SCSI timeout value from 30 seconds to 60 seconds by running the `set_target_timeout.sh`. You can download this shell script from the following website:

[Emulex](#)

Selecting **Linux Tools** on the Emulex Linux driver download website. The timeout value is a dynamic variable and can be changed even while I/O is being served on the devices.

Example: Emulex changing timeout script:

```
# ./set_target_timeout.sh <host_num> <target_id> <cmd_timeout>

# ls /sys/class/scsi_host/host2/device

... target2:0:0
```

The SCSI instance number is 2 and target is 0 from the above output:

```
# ./set_target_timeout 2 0 60
modifying device /sys/class/scsi_device/2:0:0:0/device
found timeout at value 30
new timeout value is 60
modifying device /sys/class/scsi_device/2:0:0:1/device
found timeout at value 30
new timeout value is 60
. . .
```

You can also manually change the timeout value using the following commands:

```
# /sys/class/scsi_device/2:0:0:0/device
# echo 60 > timeout
# cat timeout
60
```

The `set_target_timeout` script needs to be executed for all the SCSI instances of `lpfc` driver; if the operation is performed manually, the command needs to be executed for all the devices.

**NOTE:** If the Emulex driver is unloaded and reloaded for any reason, the timeout setting will reset to the default setting of 30 seconds for all Emulex attached devices. If this occurs, set the timeout value back to 60 seconds using any of the described methods. This is not applicable if the timeout is changed using the `udev` rule.

## Setting Up Multipathing Software

HP supports the following multipath solutions for RHEL:

- Device-mapper
- Veritas Dynamic MultiPathing (DMP)

### Setting Up Device-mapper

Check for installed Device-mapper packages by issuing `rpm -qa | grep device-mapper`.

**NOTE:** If necessary, install the `device-mapper-multipath` package using the RHEL tools.



You can use the following commands to configure multipath devices:

- `multipath` inspects Linux devices to see if there are multiple paths to the same device and communicates to the kernel device-mapper to set up a device map (dm) device for the device and is responsible for the path coalescing and device map creation.
- The `multipathd` daemon checks path health and will reconfigure the multipath map whenever a path comes up or goes down so as to maintain correctly the path mapping state.
- `kpartx` reads partition tables on specified devices and creates device maps over partition segments that are detected.

Device-mapper also depends on the `udev` and `sysfsutils` filesystem packages. `udev` is a user space process which dynamically manages the creation of devices under the `/dev/` filesystem. The `sysfsutils` package exports the view of the system hardware configuration to `udev` userspace process for device node creation. These packages must be present on the system.

For example:

```
# rpm -qa | grep udev
udev-039-10.19.el4

# rpm -qa | grep sysfs
sysfsutils-devel-1.2.0-1
sysfsutils-1.2.0-1
```

In RHEL 5.4, the following packages appear after installation:

```
# rpm -qa | grep udev
udev-095-14.21.el5

# rpm -qa | grep sysfs
libsysfs-2.0.0-6
sysfsutils-2.0.0-6
```

If `/usr` is a separate partition and is not part of the root (`/`) partition in the installed RHEL Operating System, then copy the shared library `libsysfs.so` and create the required `symlinks` from the `/usr/lib` directory to the `/lib` directory.

The following examples show partitions for 32-bit and 64-bit operating systems:

- On a 32-bit installed operating system:

```
# cp /usr/lib/libsysfs.so.1.0.2 /lib/
# ln -s /lib/libsysfs.so.1.0.2 /lib/libsysfs.so.1
# ln -s /lib/libsysfs.so.1 /lib/libsysfs.so
```

- On 64-bit installed operating system:

```
# cp /usr/lib64/libsysfs.so.1.0.2 /lib64/
# ln -s /lib64/libsysfs.so.1.0.2 /lib64/libsysfs.so.1
# ln -s /lib64/libsysfs.so.1 /lib64/libsysfs.so
```



**CAUTION:** If `/usr` is a separate partition, there will be a system hang during bootup when `multipath` starts and cannot find the shared library `libsysfs.so.1` because `/usr` partition gets mounted at the later stage of the boot process. So, copying the shared library `libsysfs.so.1` to the `/lib` directory will resolve the issue.

---

**NOTE:** The `sysfsutils-xx` package contains the `libsysfs.so.1` library. If any upgrades are made to this package, the new library file should be copied over to the `/lib` directory.

---

## Modifying the `/etc/multipath.conf` File

The `/etc/multipath.conf` file is used by Device-mapper where the multipathing parameters have been set. The default installed `/etc/multipath.conf` file must be edited with the following changes for a minimum configuration connecting to an HP 3PAR StoreServ Storage array. Entries listed in `multipath.conf` override the default kernel parameters for `dm-multipath`. In general, the kernel defaults are sufficient with the exception of the devices entries for HP 3PAR. In the specific case of booting the host from an HP 3PAR StoreServ Storage volume (a.k.a SAN boot), there are additional defaults entries required:

---

**NOTE:** See “[Booting the Host from the HP 3PAR StoreServ Storage](#)” (page 126) for SAN boot requirements.

See the RHEL document *DM Multipath Configuration and Administration* for additional options in `multipath.conf` entries. Search the following website for the appropriate version of this document:

[Red Hat](#)

---

1. Remove or comment out all entries in the `/etc/multipath.conf` file except for the devices section of devices currently in use.
2. Edit the devices structure to add entries for HP 3PAR array and remove other product entries that are not needed.

After all of the edits are made, the relevant sections of `/etc/multipath.conf` should appear as follows if the HP 3PAR array that the RHEL server is connecting to is running HP 3PAR OS 3.1.1 or 3.1.2:

For RHEL 6.2 or Later

```
# cat /etc/multipath.conf
defaults {
    polling_interval          10
    max_fds                  8192
}

devices {
    device {
        vendor                "3PARdata"
        product               "VV"
        no_path_retry         18
        features               "0"
        hardware_handler      "0"
        path_grouping_policy   multibus
        getuid_callout         "/lib/udev/scsi_id --whitelisted --device=/dev/%n"

        path_selector          "round-robin 0"
        rr_weight              uniform
        rr_min_io_rq           1
        path_checker           tur
        failback               immediate
    }
}
```

## For RHEL 6.1

```
# cat /etc/multipath.conf
defaults {
    polling_interval          10
    max_fds                  8192
}

devices {
    device {
        vendor                "3PARdata"
        product               "VV"
        no_path_retry         18
        features               "0"
        hardware_handler       "0"
        path_grouping_policy   multibus
        getuid_callout         "/lib/udev/scsi_id --whitelisted --device=/dev/%n"

        path_selector          "round-robin 0"
        rr_weight              uniform
        rr_min_io              1
        path_checker            tur
        failback               immediate
    }
}
```

## For RHEL 5.6 or Later

```
# cat /etc/multipath.conf
defaults {
    polling_interval          10
}

devices {
    device {
        vendor                "3PARdata"
        product               "VV"
        no_path_retry         18
        features               "0"
        hardware_handler       "0"
        path_grouping_policy   multibus
        getuid_callout         "/sbin/scsi_id -g -u -s /block/%n"
        path_selector          "round-robin 0"
        rr_weight              uniform
        rr_min_io              100
        path_checker            tur
        failback               immediate
    }
}
```

## For RHEL 4.x through RHEL 5.5

```
cat /etc/multipath.conf
defaults {
}

devices {
    device {
        vendor                "3PARdata"
        product               "VV"
        no_path_retry         18
        features               "0"
```

```
hardware_handler      "0"
path_grouping_policy  multibus
getuid_callout        "/sbin/scsi_id -g -u -s  /block/%n"
path_selector         "round-robin 0"
rr_weight             uniform
rr_min_io             100
path_checker          tur
failback              immediate
polling_interval      10
}
}
```

**NOTE:** If the HP 3PAR array that the RHEL server is connecting to is running an HP 3PAR OS version earlier than 3.1.1, you must change the `no_path_retry` setting to 12 rather than 18, and the `polling_interval` setting to 5 rather than 10.

If the HP 3PAR array that the RHEL server is connecting to is running an HP 3PAR OS 3.1.3 or later, host persona 2 (ALUA) is recommended. When host persona 2 is used, you must modify the `/etc/multipath.conf` file for ALUA support.

When changing from HP 3PAR host persona 1 to host persona 2 or vice versa:

- A change from persona 1 to persona 2, or from persona 2 to persona 1, requires that the array ports affected be taken offline, or that the host for which the persona is being changed be not connected (not logged in). This is an HP 3PAR OS requirement.
- For existing devices targeted in a persona to be claimed, the host must be rebooted.

Use the following procedure:

- a. Stop all host I/O and modify the `/etc/multipath.conf` file on the RHEL host.
- b. Shut down the host.
- c. Change the host persona on the array.
- d. Boot the host.
- e. Verify that the target devices have been claimed properly and that the persona setting is correct.

In addition, a SAN boot configuration requires rebuilding of the ramdisk in order to take effect.

## For the ALUA Setting in RHEL 6.1 or Later

```
# cat /etc/multipath.conf
defaults {
    user_friendly_names      no
    polling_interval         10
    max_fds                  8192
}
devices {
    device {
        vendor                "3PARdata"
        product               "VV"
        features               "0"
        hardware_handler      "1 alua"
        path_selector          "round-robin 0"
        getuid_callout         "/lib/udev/scsi_id --whitelisted --device=/dev/%n"
        path_grouping_policy   "group_by_prio"
        prio                   "alua"
        failback               "immediate"
        rr_weight              "uniform"
        no_path_retry          18
        rr_min_io_rq           1
        path_checker           "tur"
    }
}
```

## For the ALUA Setting in RHEL 5.8 Later

```
# cat /etc/multipath.conf
defaults {
    user_friendly_names      no
    polling_interval         10}
devices {
    device {
        vendor                "3PARdata"
        product               "vv"
        features               "0"
        path_selector          "round-robin 0"
        getuid_callout         "/sbin/scsi_id -g -u -s /block/%n"
        hardware_handler      "1 alua"
        path_grouping_policy   "group_by_prio"
        prio_callout           "/sbin/mpath_prio_alua /dev/%n"
        failback               "immediate"
        rr_weight              "uniform"
        no_path_retry          18
        rr_min_io              100
        path_checker           "tur"
    }
}
```

## Enabling Multipath

Perform the following actions to enable multipath.

1. Invoke the `multipath` command for any name changes to be effective.

2. Verify that the `multipathd` daemon is enabled by the `rc` script to run on every host boot up. The following output shows that it is enabled for run-level 3, 4 and 5. Enable it appropriately for your configuration:

```
# chkconfig --list multipathd
multipathd 0:off 1:off 2:off 3:on 4:on 5:on 6:off
```

3. Check that the appropriate `rc` scripts have been created for each run level. The start number(s) may not match those shown here.

```
# ls /etc/rc3.d/*multi*
/etc/rc3.d/S13multipathd
# ls /etc/rc5.d/*multi*
/etc/rc5.d/S13multipathd
```

You can also use the `chkconfig` command to enable multipathing:

```
# chkconfig multipathd on
```

## Setting Up Veritas DMP Multipathing

For Active/Active multipath load balancing and failover, install Veritas Storage Foundation and High Availability Software, following the instructions provided in the Veritas Storage Foundation installation and administrator guides, available on the following website:

[Symantec](#)

---

**NOTE:** Veritas Cluster V6.0.1 is supported on RHEL 6.x with HP 3PAR OS 3.1.1 or later.

If you are using QLogic HBAs, the QLogic non-failover driver should be installed for Veritas DMP support.

Device-mapper (DM) or multipath modules should not be configured when Veritas DMP is used for multipathing.

---

Check the configuration of the Device-mapper module with `chkconfig --list multipathd` and turn it off with `chkconfig multipathd off`.

It is required to have the Veritas Array Support Library (ASL) for the HP 3PAR StoreServ Storage installed on the RHEL host if you are using a Veritas Storage Foundation version prior to 5.0mp3.

As of HP 3PAR OS 3.1.2, the virtual volume (VV) WWN increased from 8 bytes to 16 bytes. The increase in WWN length may cause the Symantec ASL to incorrectly identify the array volume identification (AVID) number, subsequently resulting in use of a different naming convention for DMP disk devices.

---

**NOTE:** This issue does not occur with Storage Foundation 6.1, which is compatible with both 8-byte and 16-byte WWNs.

---

The standard naming convention is as follows:

<enclosure\_name><enclosure\_number>\_<AVID>

For example:

```
3pardata4_5876
3pardata4_5877
3pardata4_5878
```

If the virtual volumes in use report a 16-byte WWN, the ASL extracts an AVID number of 0 for all VVs, and Symantec sequentially enumerates the DMP devices to generate a unique DMP disk name. In this case, the resulting disk names would be:

```
3pardata4_0
3pardata4_0_1
3pardata4_0_2
```

The name scheme used does not impact DMP functionality. However, if you want the DMP name to contain the VV AVID number, Symantec provides updated ASLs that will properly extract the AVID number. If AVID naming is desired, use the following ASL versions:

**Storage Foundation 5.1 (all)** 3PAR ASL version 5.1.134.100 or later

**Storage Foundation 6.0 to 6.0.4** ASL version 6.0.400.100 or above

To obtain the Veritas ASL for the HP 3PAR StoreServ Storage, complete the following tasks:

1. Download the latest Veritas ASL for the HP 3PAR StoreServ Storage System from the following website:

[Symantec](#)

Select 3PAR as the vendor. For ASLs for SFHA versions earlier than 5.0, see this technical note:

[Symantec TECH61169](#)

---

**NOTE:** Specific models of HP 3PAR StoreServ Storage arrays may not be listed on the website, but the ASL works on all models of HP 3PAR StoreServ Storage arrays.

---

2. To install the ASL, the Veritas `vxconfigd` daemon must be running. Running `vxinstall` will start the daemon. Once you install the ASL package, you must run the `vxctl enable` command to claim the disk array as an HP 3PAR StoreServ Storage array.
3. Configure the Veritas `vxvmp` driver to manage the HP 3PAR StoreServ Storage paths providing path failure management and dynamic load balancing.

4. To confirm that the Veritas vxddmp driver has registered and claimed the HP 3PAR StoreServ Storage, issue the following Veritas command:

```
# vxddladm listsupport libname=libvx3par.so
ATTR_NAME ATTR_VALUE
=====
LIBNAME libvx3par.so
VID 3PARdata
PID VV
ARRAY_TYPE A/A
ARRAY_NAME 3PARDATA
```

If you are using the Veritas Storage Foundation version 5.0mp3 or higher, then you do not need to install the ASL for the HP 3PAR StoreServ Storage. To verify that the HP 3PAR StoreServ Storage is recognized and supported by the installation, run the following command:

```
# vxddladm listsupport libname=libvx3par.so
ATTR_NAME ATTR_VALUE
=====
LIBNAME libvx3par.so
VID 3PARdata
PID VV
ARRAY_TYPE A/A
ARRAY_NAME 3PARDATA
```

However, if the output does not show the HP 3PAR StoreServ Storage, perform the following step to have the storage server added as a 3PARDATA device:

```
# vxddladm addsupport all
```

Then verify that the HP 3PAR StoreServ Storage is supported, as shown in the following example.

```
# vxddladm listsupport libname=libvx3par.so
ATTR_NAME ATTR_VALUE
=====
LIBNAME libvx3par.so
VID 3PARdata
PID VV
ARRAY_TYPE A/A
ARRAY_NAME 3PARDATA
```

**⚠ WARNING!** If the ARRAY\_NAME is not designated as 3PARDATA, the multipathing layer may not discover devices correctly.

## Installing the HP 3PAR Host Explorer Package

With HP 3PAR OS 2.3.1 and OS 3.1.x, the Host Explorer daemon running on the RHEL server can send information about the host configuration to an HP 3PAR StoreServ Storage over the Fibre Channel link. For installation and activation of this package, see the *HP 3PAR Host Explorer User's Guide* on the HP SC website:

[HP Support Center](#)



## 6 Configuring a Host with iSCSI

### Setting Up the Switch and iSCSI Initiator

Connect the Linux host iSCSI initiator port(s) and the HP 3PAR StoreServ Storage iSCSI target ports to the switch(es).

If you are using VLANs, make sure that the switch ports which connect to the HP 3PAR StoreServ Storage iSCSI target ports and iSCSI initiator ports reside in the same VLANs and/or that you can route the iSCSI traffic between the iSCSI initiator ports and the HP 3PAR StoreServ Storage iSCSI target ports. Once the iSCSI initiator and HP 3PAR StoreServ Storage iSCSI target ports are configured and connected to the switch, you can use the `ping` command on the iSCSI initiator host to make sure it sees the HP 3PAR StoreServ Storage iSCSI target ports.

**NOTE:** Setting up the switch for VLAN and routing configuration is beyond the scope of this document. Consult your switch manufacturer's guide for instructions about setting up VLANs and routing.

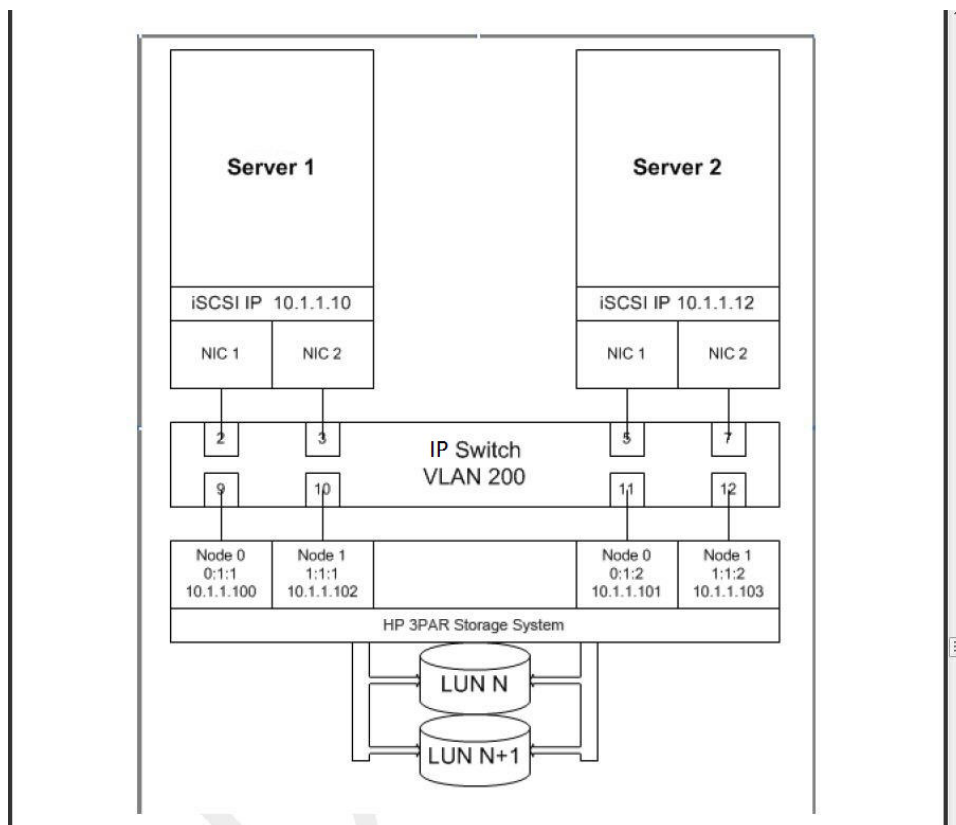
The procedures in this chapter assume that you have completed the following tasks:

- Set up and configuration of the host Network Interface Card (NIC) or converged network adapter (CNA) as Initiator port that will be used by the iSCSI Initiator software to connect to the HP 3PAR StoreServ Storage iSCSI target ports.
- Installation of the iSCSI initiator software package.

### Configuring RHEL 6 or RHEL 5 for Software and Hardware iSCSI

This section describes the procedures for setting up an RHEL software/hardware iSCSI configuration with an HP 3PAR StoreServ Storage. [Figure 3 \(page 57\)](#) shows an iSCSI topology.

**Figure 3 iSCSI Topology**



Connect the RHEL host iSCSI initiator port(s) and the HP 3PAR StoreServ Storage iSCSI target ports to the switch(es).

If you are using VLANs, make sure that the switch ports which connect to the HP 3PAR StoreServ Storage iSCSI target ports and iSCSI initiator ports reside in the same VLANs and/or that you can route the iSCSI traffic between the iSCSI initiator ports and the HP 3PAR StoreServ Storage iSCSI target ports. Once the iSCSI initiator and HP 3PAR StoreServ Storage iSCSI target ports are configured and connected to the switch, you can use the ping command on the iSCSI initiator host to make sure it sees the HP 3PAR StoreServ Storage iSCSI target ports.

---

**NOTE:** Setting up the switch for VLAN and routing configuration is beyond the scope of this document. Consult your switch manufacturer's guide for instructions about setting up VLANs and routing.

---

The procedures in this chapter assume that you have completed the following tasks:

- Setup and configuration of the host Network Interface Card (NIC) or converged network adapter (CNA) as Initiator port that will be used by the iSCSI Initiator software to connect to the HP 3PAR StoreServ Storage iSCSI target ports.
- Installation of the iSCSI initiator software package.

## Installing iSCSI on RHEL 6 or RHEL 5

iSCSI is installed through the `iscsi-initiator-utils` driver and `rpm` package by default during the RHEL installation. There are a couple of ways to configure and start `iscsi-initiator-utils` on RHEL: either by using the various `iscsi-initiator-utils` commands available from the RHEL CLI or through the GUI.

This document references the `iscsi-initiator-utils` commands from the RHEL CLI. The `iscsiadm` utility is a command-line tool that allows discovery and login to iSCSI targets. This tool also provides access and management of the `open-iscsi` database. The following steps are required to discover iSCSI sessions:

1. Discover targets at a given IP address.
2. Establish iSCSI login with the node record ID found in the discovery process.
3. Record iSCSI session statistics information.

## Setting Up Software iSCSI for RHEL 6 or RHEL 5

You can adjust the iSCSI timers for better iSCSI session management and iSCSI I/O path management. iSCSI timers and session parameters are specified in `/etc/iscsi/iscsid.conf` file.

The `replacement_timeout` iSCSI timeout parameter prevents I/O errors from propagating to the application by controlling how long the iSCSI layer should wait for a timed-out path/session to reestablish itself before failing any commands on it. The default `replacement_timeout` value is 120 seconds.

To adjust `replacement_timeout`, complete the following steps:

1. Open `/etc/iscsi/iscsid.conf` and edit the following line:

```
node.session.timeo.replacement_timeout = [replacement_timeout]
```

2. Set this parameter to 10 seconds for a faster failover.

```
node.session.timeo.replacement_timeout = 10
```

3. To control how often a ping is sent by the iSCSI initiator to the iSCSI target, change the following parameter.

```
node.conn[0].timeo.noop_out_interval = [replacement_timeout]
```

To detect problems quickly in the network, the iSCSI layer sends iSCSI pings to the target. If the ping times out, the iSCSI layer responds by failing running commands on the path where the pings failed.

4. Set this parameter to 10 seconds.

```
node.conn[0].timeo.noop_out_interval = 10
```

5. To set the host log into the iSCSI nodes every time the iSCSI daemon is started or the host is rebooted, edit the iSCSI configuration in `/etc/iscsi/iscsid.conf` and change the values of the following default settings:

```
node.startup = automatic
node.conn[0].startup = automatic
```

**NOTE:** The `node.conn[0].startup` variable is optional and not defined in the default `iscsid` configuration file.

6. Check the state of the iSCSI service run level with the `chkconfig` command:

```
# chkconfig --list | grep iscsi
iscsi          0:off  1:off  2:off  3:off  4:off  5:off  6:off
iscsid         0:off  1:off  2:off  3:on   4:on   5:on   6:off
```

7. Verify that Run level 5 is turned on. If not turned on, issue the following commands:

```
# chkconfig iscsi on
# chkconfig --list|grep iscsi
iscsi          0:off  1:off  2:on   3:on   4:on   5:on   6:off
iscsid         0:off  1:off  2:off  3:on   4:on   5:on   6:off
```

8. Session and device queue depth in `/etc/iscsi/iscsid.conf` may require tuning depending on your particular configuration. `node.session.cmds_max` controls how many commands the session will queue. `node.session.queue_depth` controls the device's queue depth.

If you are deploying HP 3PAR Priority Optimization software, you may need to increase or max out the `node.session.cmds_max` and `node.session.queue_depth` values to ensure the host has sufficient I/O throughput to support this feature. For complete details of how to use HP 3PAR Priority Optimization (Quality of Service) on HP 3PAR StoreServ Storage arrays, see the *HP 3PAR Priority Optimization* technical white paper, available on the following website:

[HP 3PAR Priority Optimization](#)

In a multihost-to-single HP 3PAR StoreServ Storage configuration when HP 3PAR Priority Optimization is not in use it is possible to overrun the array target port I/O queues or experience queue starvation for some hosts due to excessive usage by other hosts. This situation is more likely when using the 1G iSCSI target ports on T-Class and F-Class HP 3PAR StoreServ

Storage arrays that have a smaller target port queue depth of 512. These situations can be mitigated by reducing the values for parameters `node.session.cmds_max` and `node.session.queue_depth` on each host that shares the array target port.

9. As an option, you can also enable the Header and Data Digest for error handling and recovery within the connection.

Typically, whenever a CRC error occurs, the SCSI layer tries to recover by disabling the connection and recovering. However, by enabling the header and data digest, individual iSCSI PDUs will be retried for recovery for those connections missing the data (CRC Error) or missing a PDU or sequence number (Header Digest). If the recovery does not occur, then the low level SCSI recovery will be initiated. The Header and Data Digest is optional since the SCSI layer will still perform CRC error recovery at the session level rather than at the PDU level.

---

**⚠ CAUTION:** Enabling Header and Data Digest will cause some I/O performance degradation due to data checking.

---

You can enable the Header and Data Digest by adding the following lines in iSCSI configuration file `/etc/iscsi/iscsid.conf`:

```
node.conn[0].iscsi.HeaderDigest = CRC32C
node.conn[0].iscsi.DataDigest = CRC32C
```

---

**NOTE:** In order for the parameter changes to take effect, restart the iSCSI service after the change.

---

10. Enable any other configuration changes such as CHAP authentication. For details, see [“Setting the Host CHAP Authentication on the HP 3PAR StoreServ Storage”](#) (page 83).

## Setting Up Hardware iSCSI for RHEL 6 or RHEL 5

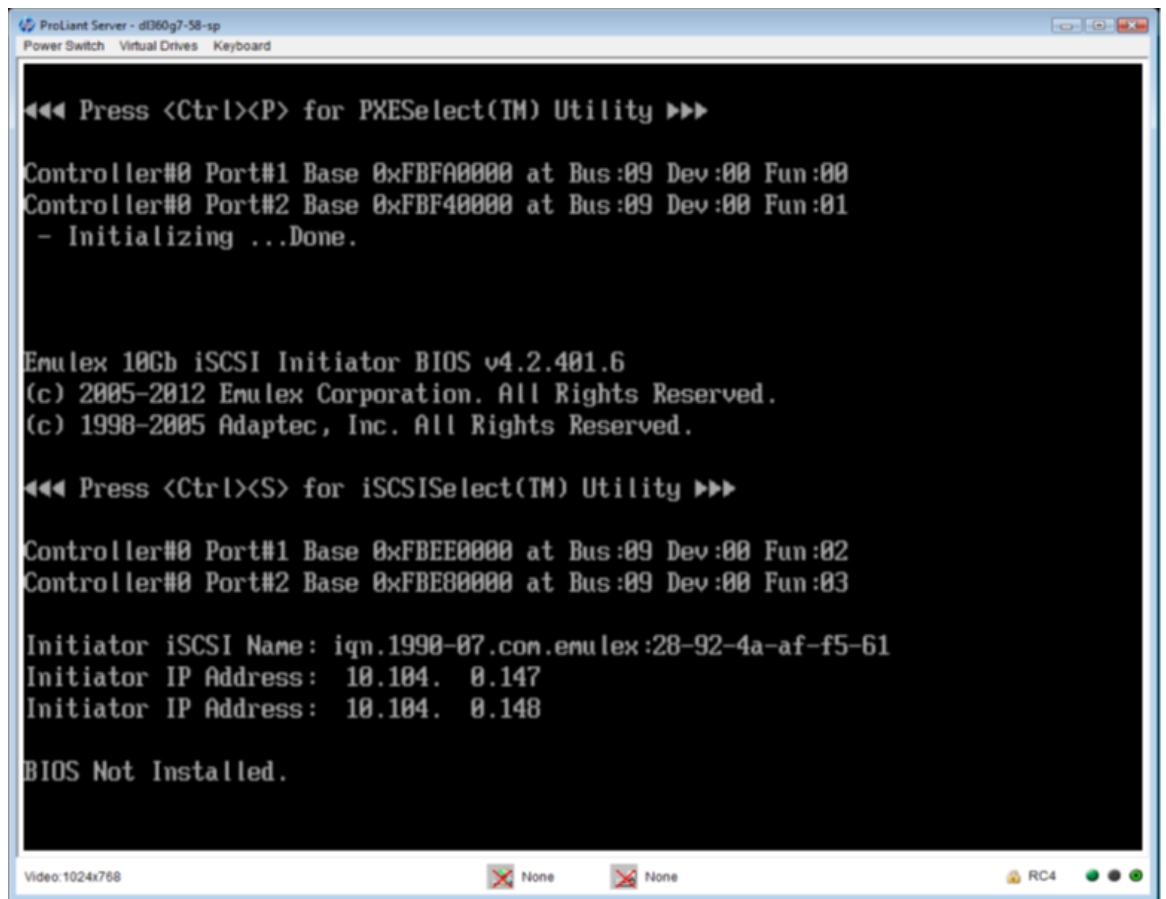
Use the BIOS to add IP addresses, and use the OneCommand Manager GUI or the `hbacmd` utility to configure hardware iSCSI. For information about setting up and configuring hardware iSCSI, see the OneCommand™Manager Command Line Interface Version 6.1 User Manual, which is available at the following website:

[Emulex](#)

### Setting IP Addresses Using BIOS

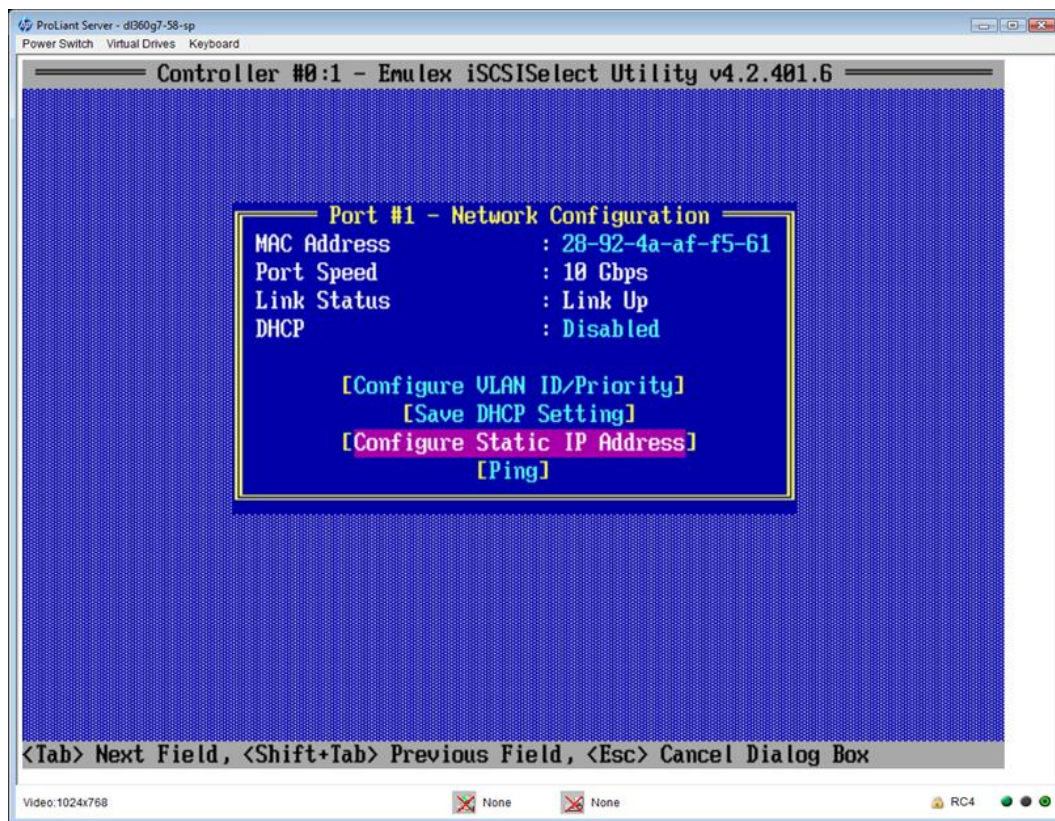
1. Using the system BIOS, add the IP addresses ([Figure 4 \(page 61\)](#)):

Figure 4 Adding IP addresses



2. In the **Network Configuration** pane, select **Configure Static IP Address**.

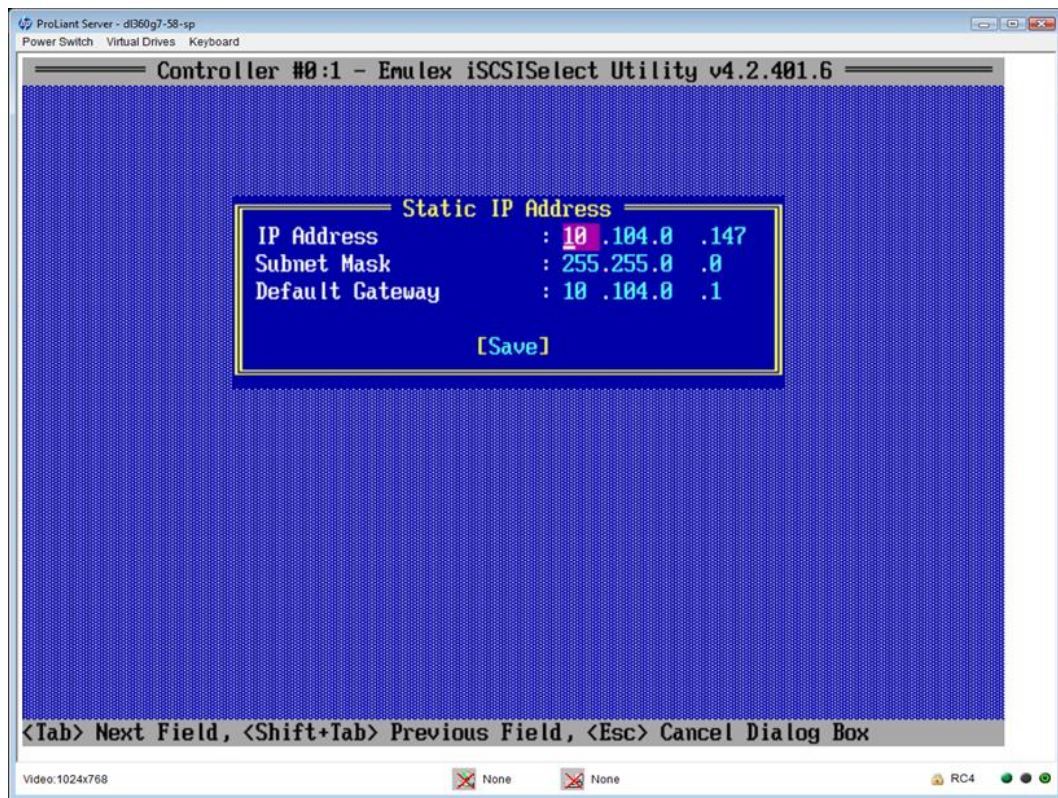
Figure 5 Configuring Static IP Address



3. In the **IP Address** field of the **Static IP Address** pane, enter the **IP Address**, **Subnet Mask**, and **Default Gateway**.



Figure 6 Entering the IP Address, Subnet Mask, and Default Gateway



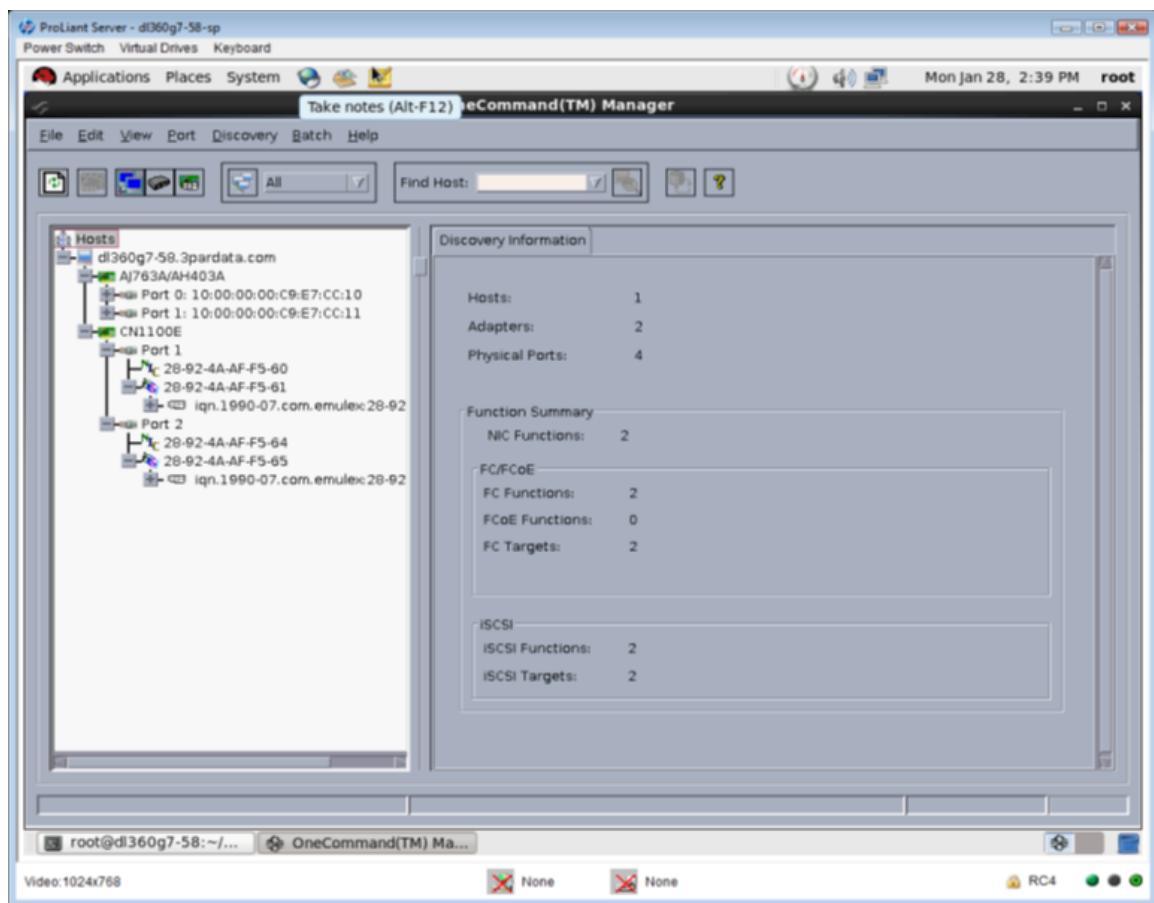
4. Save the changes and reboot the server.

### Using the OneCommand Manager GUI

To configure hardware iSCSI using the OneCommand Manager GUI, follow these steps:

1. Issue the `/usr/sbin/ocmanager/ocmanager` & command to open the OneCommand Manager and configure hardware iSCSI.

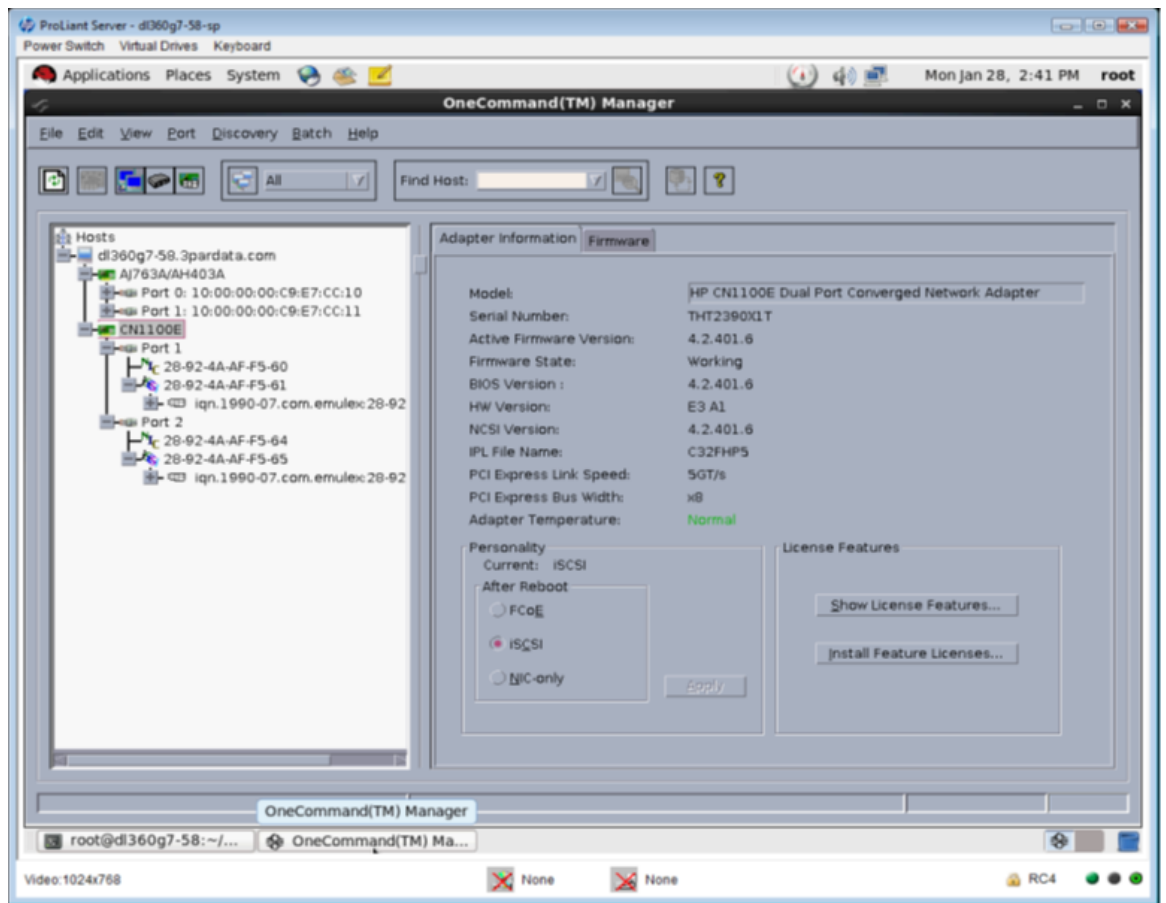
Figure 7 Configuring hardware iSCSI



2. On the **Adapter information** tab, in the **Personality** pane, make sure that **Personality** is set to **iSCSI**.

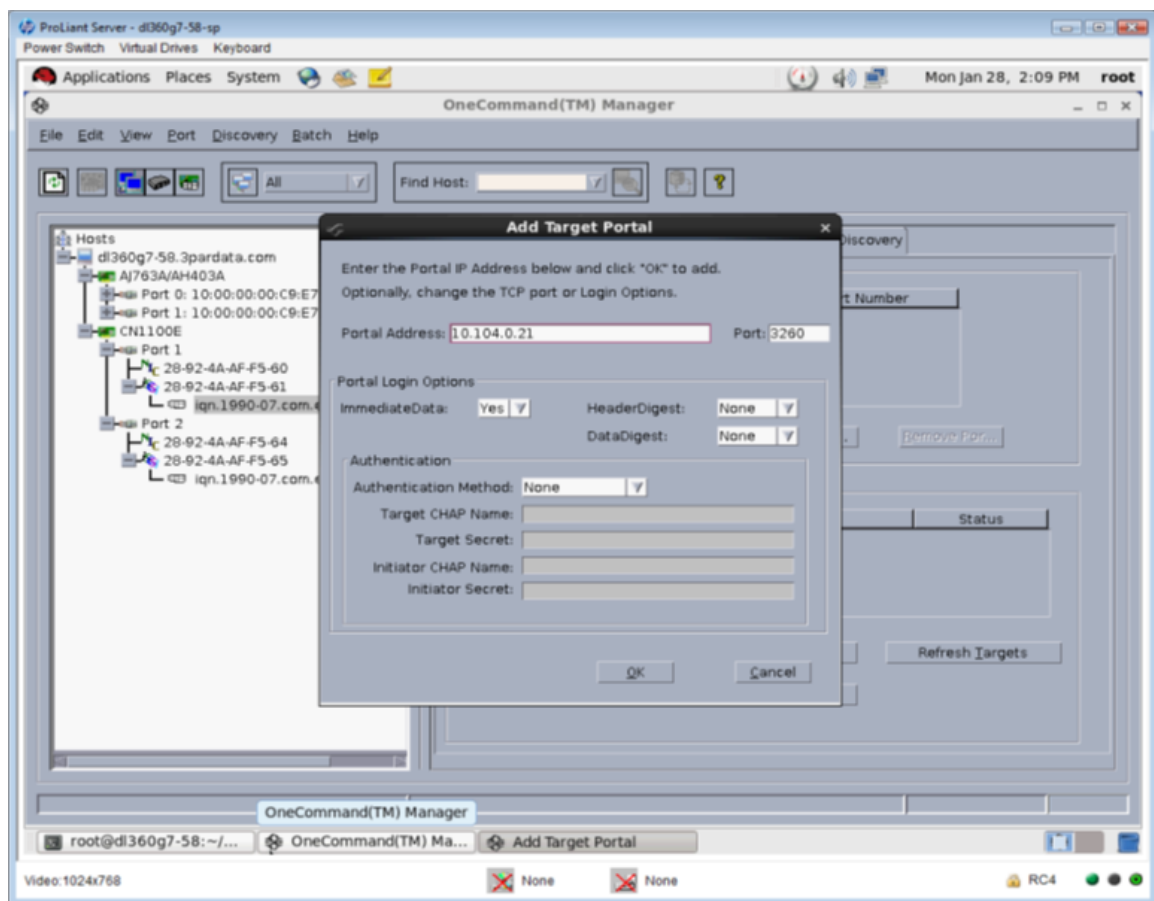


Figure 8 Setting Personality to iSCSI



3. Add the target portal on port 0:2:1.

Figure 9 Adding the Target Portal



**NOTE:** To list the HP 3PAR StoreServ target ports, issue the `showport -iscsi` command:

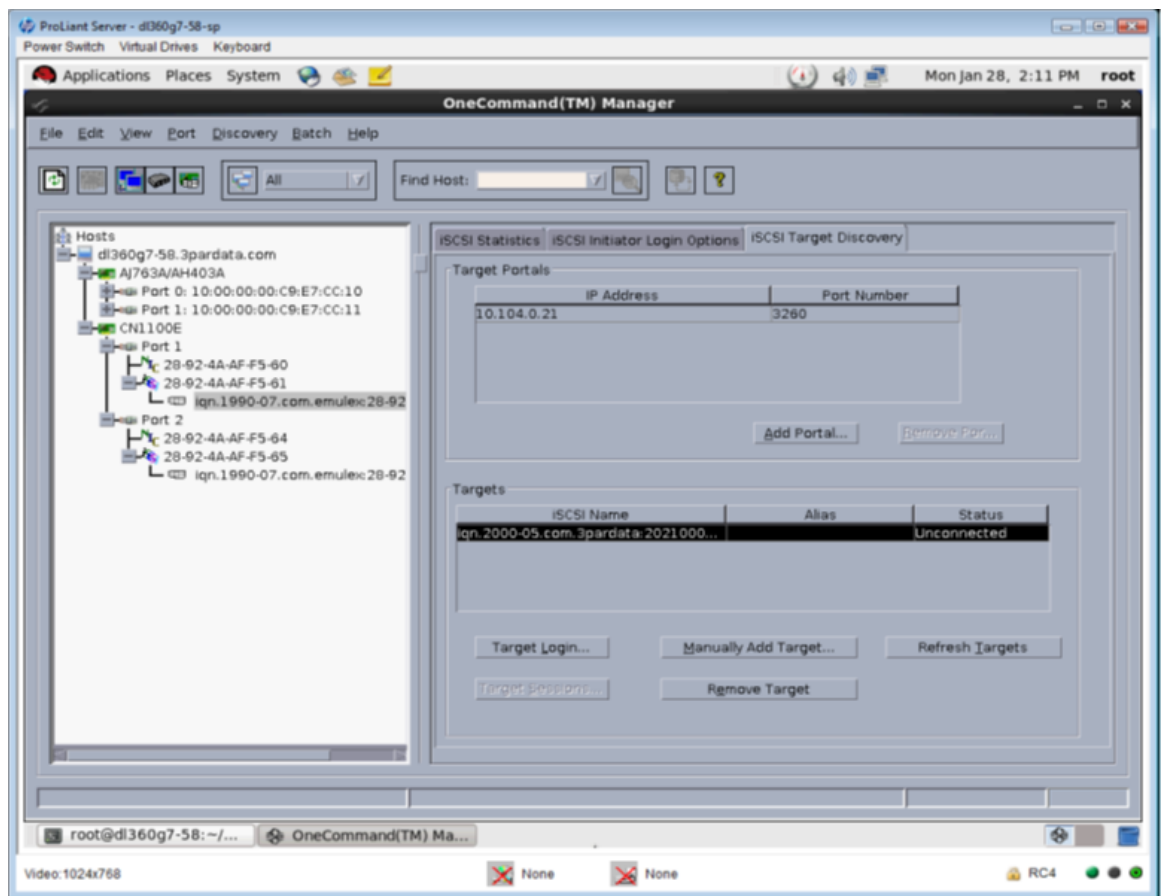
# `showport -iscsi`

N:S:P State	IPAddr	Netmask	Gateway	TPGT	MTU	Rate	DHCP	iSNS_Primary	iSNS_Sec	iSNS_Port
0:3:1 offline	0.0.0.0	0.0.0.0	0.0.0.0	31	1500	n/a	0	0.0.0.0	0.0.0.0	3205
0:3:2 loss_sync	0.0.0.0	0.0.0.0	0.0.0.0	32	1500	n/a	0	0.0.0.0	0.0.0.0	3205
1:3:1 offline	0.0.0.0	0.0.0.0	0.0.0.0	131	1500	n/a	0	0.0.0.0	0.0.0.0	3205
1:3:2 loss_sync	0.0.0.0	0.0.0.0	0.0.0.0	132	1500	n/a	0	0.0.0.0	0.0.0.0	3205

4

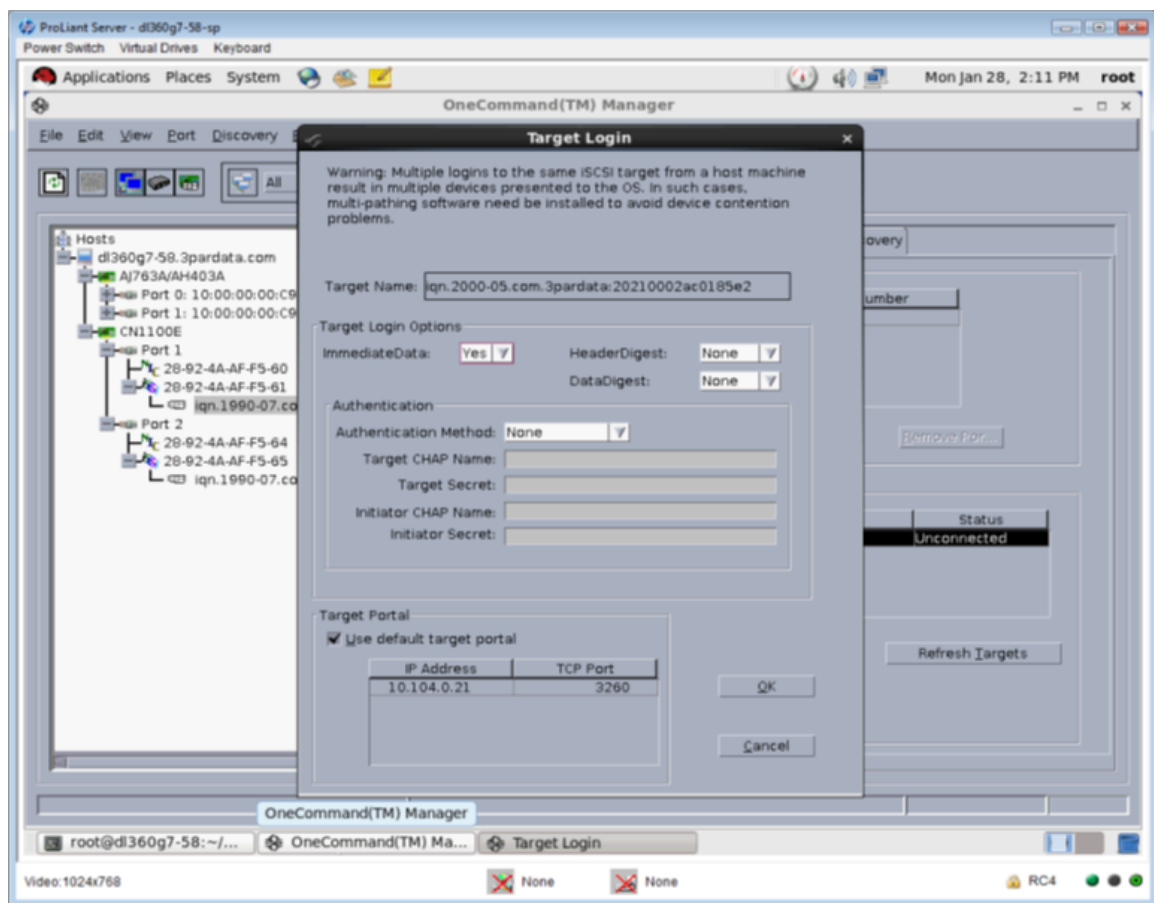
4. Highlight the target.

Figure 10 Highlighting the Target



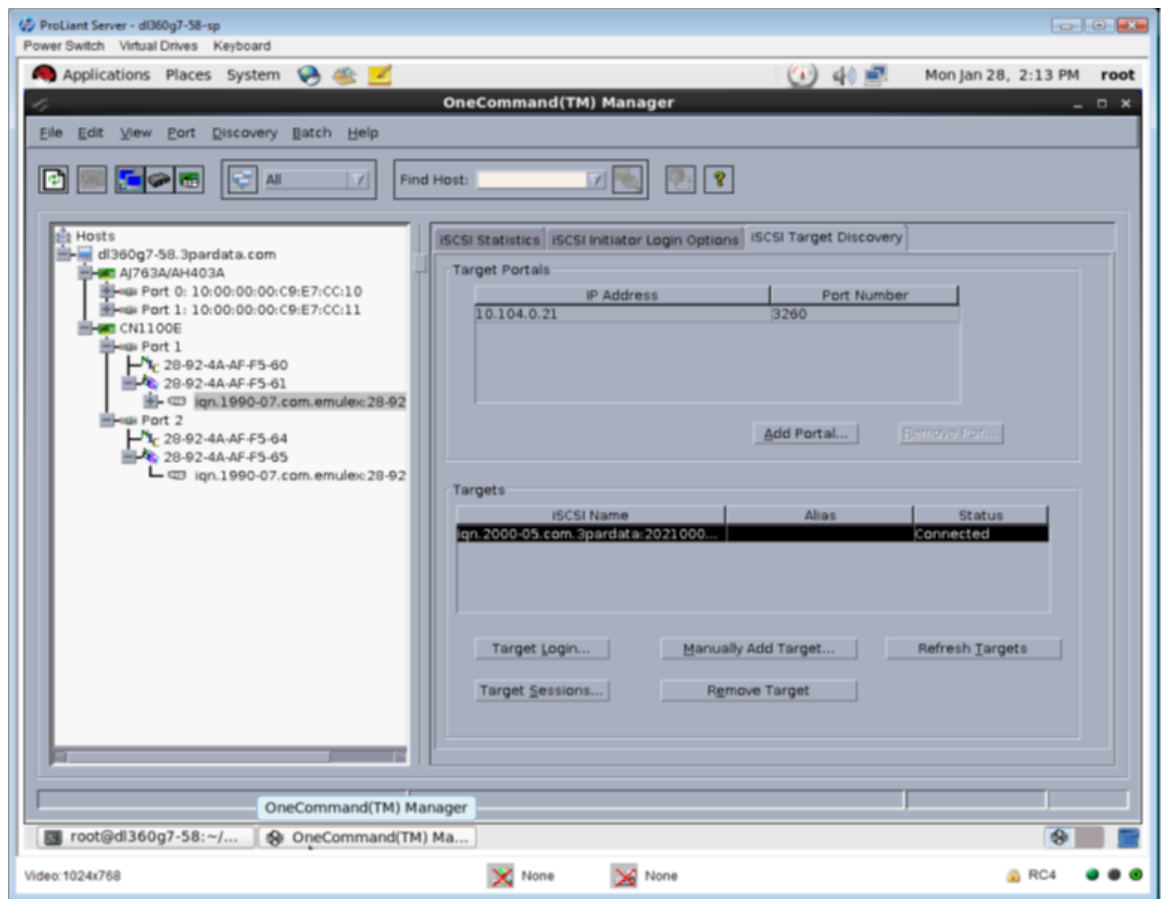
5. Click **Target Login...** and accept the default settings.

Figure 11 Selecting the Default



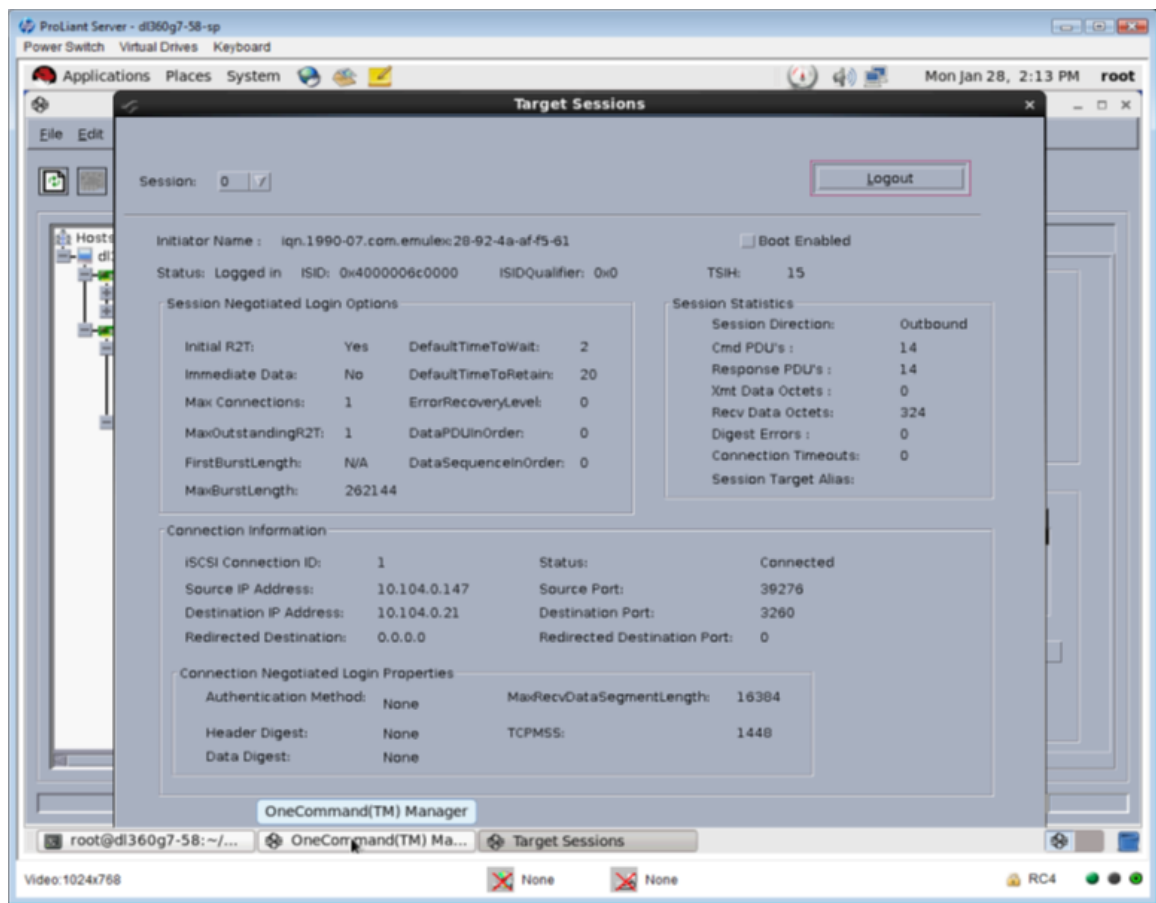
6. Highlight the now-connected target.

Figure 12 Highlighting the Connected Target



7. To view the established sessions, click **Target Sessions...**

Figure 13 Listing the Target Session



Use the initiator name to create the host definition by issuing the HP 3PAR OS CLI `createhost -iscsi -persona <n> <host name> <iSCSI Initiator name>` command:

- On an HP 3PAR StoreServ Storage running HP 3PAR OS 3.1.2 or earlier, or OS 2.3.x, use the `createhost` command with the `-persona 1` option:

```
# createhost -iscsi -persona 1 redhathost iqn.1990-07.com.emulex:28-92-4a-af-f5-61
```

- HP 3PAR StoreServ Storage running HP 3PAR OS 3.1.3 or later, use the `createhost` command with the `-persona 2` option:

```
# createhost -iscsi -persona 2 redhathost iqn.1990-07.com.emulex:28-92-4a-af-f5-61
```

LUNs can now be presented to the initiator's iSCSI IQN:

`iqn.1990-07.com.emulex:28-92-4a-af-f5-61`

(See “Listing the Target Session” (page 70).)

## Using the `hbacmd` Utility

Use the following `hbacmd` command to discover version information and a list of iSCSI commands.

Make sure to use the correct hbaconf utility version to configure hardware iSCSI.

```
# hbaconf version
OneCommand Manager Library Versions:
Command Line Interface      : 6.1.34.2 (Local-only mode)
RMAPI                       : 34.1.34.2
Discovery                   : 24.1.34.2
DFC Library                  : 4.2.24
MILI Service                 : 4.2.392.1
```

**NOTE:** Check the HP Support & Drivers website for the hardware support for hardware iSCSI:  
[HP Support](#)

For information about hardware iSCSI usage, issue the `hbaconf help` command:

```
# hbaconf help
```

To make sure the personality is set to active and configured on the iSCSI, issue the following command:

```
# hbaconf ShowPersonalities 28-92-4a-af-f5-61
Adapter Personalities:
NIC
iSCSI (active & configured)
FCoE
```

To list the IP address of the hardware iSCSI, issue the following command:

```
# hbaconf GetNetworkConfiguration 28-92-4a-af-f5-61
TCP/IP Configuration for 28-92-4a-af-f5-61:
DHCP Enabled:    No
VLAN Enabled:    NO
VLAN ID:         0
Priority:        0
IP Address:      10.104.0.147
Subnet Mask:     255.255.0.0
Gateway:         10.104.0.1
```

To list the hardware iSCSI session, issue the following command:

```
# hbaconf ListSessions 28-92-4a-af-f5-61 iqn.2000-05.com.3pardata:20210002ac0185e2
Total Sessions:      1
Session 1
Initiator Name:       iqn.1990-07.com.emulex:28-92-4a-af-f5-61
Status:               Open
TSIH:                 15
ISID:                 0x40000006c0000
ISID Qualifier:       0
Target IP Address:    10.104.0.21
iSCSI Boot:           No
```

To check the hardware iSCSI session information, issue the following command:

```
# hbacmd GetSessionInfo 28-92-4a-af-f5-61 iqn.2000-05.com.3pardata:20210002ac0185e2 15
Session Info for:
TSIH:                      15
ISID Qualifier:            0

Session Negotiated Login Options
-----
ImmediateData:             No
MaxConnections:            1
MaxOutstandingsR2T:        1
FirstBurstLength:          N/A
MaxBurstLength:            262144
DefaultTime2Wait:          2
DefaultTime2Retain:        20
ErrorRecoveryLevel:        0
DataPDUInOrder:            0
DataSequenceInOrder:       0

Session Statistics
-----
Session Direction:         Outbound
Cmd PDUs:                  17
Response PDUs:             17
Xmit Data Octets:          0
Recv Data Octets:          324
Digest Errors:             0
Connection Timeout Errors: 0
Session Target Alias:

Connection Information
-----
iSCSI Connection ID:       1
Status:                    Logged-In
Source IP Address:         10.104.0.147
Source Port:               60060
Destination IP Address:    10.104.0.21
Destination Port:          3260
Redirected Destination IP Address: 0.0.0.0
Redirected Destination Port: 0

Connection Negotiated Login Options
-----
Authentication Method:     Mutual CHAP
HeaderDigest:              CRC32C
DataDigest:                CRC32C
MaxSendDataSegmentLength:  16384
TCPMSS:                    1448
```

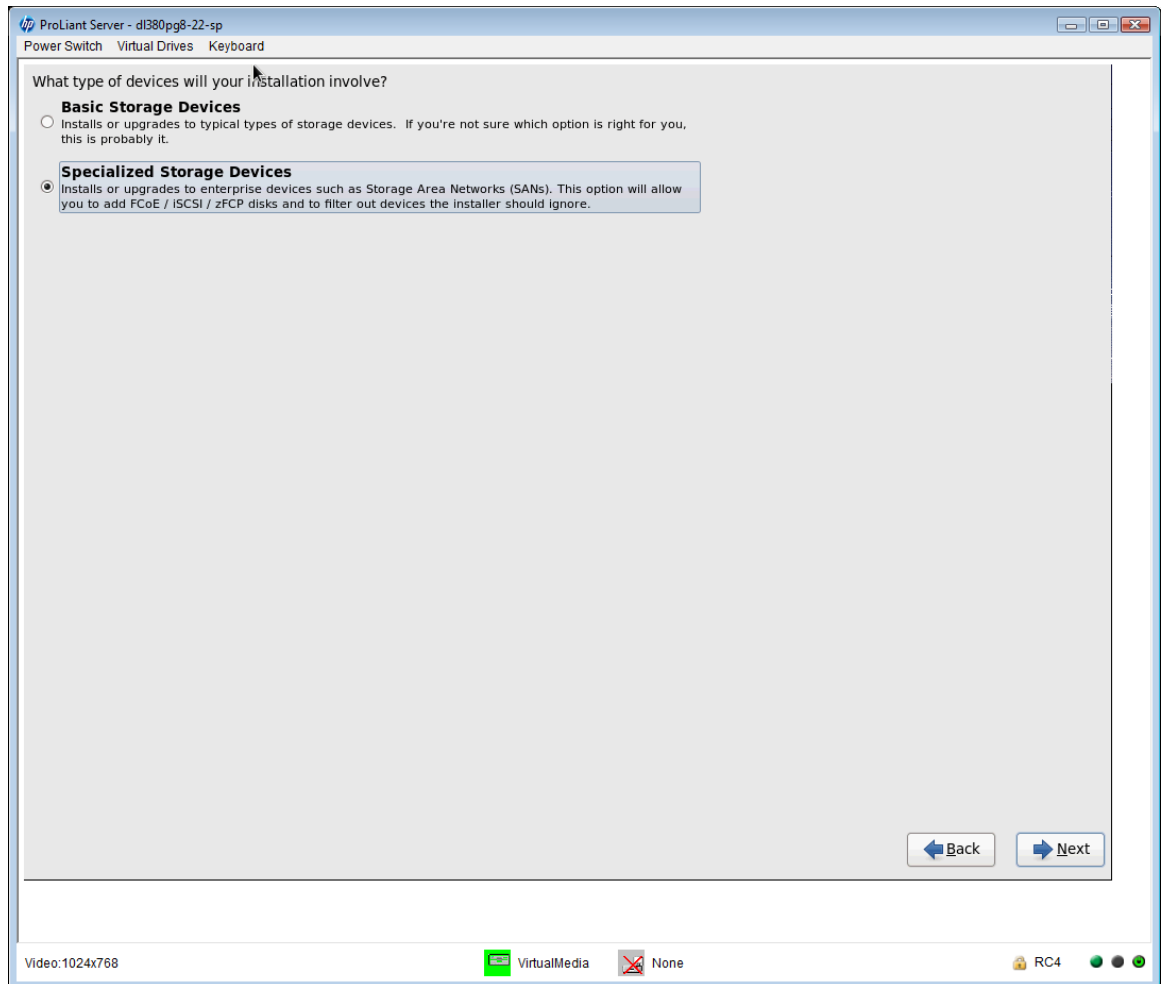
Use the BIOS to add IP addresses, and use the OneCommand Manager GUI or the hbacmd utility to configure hardware iSCSI.



A SAN boot on hardware iSCSI requires the SAN boot driver for the installation.

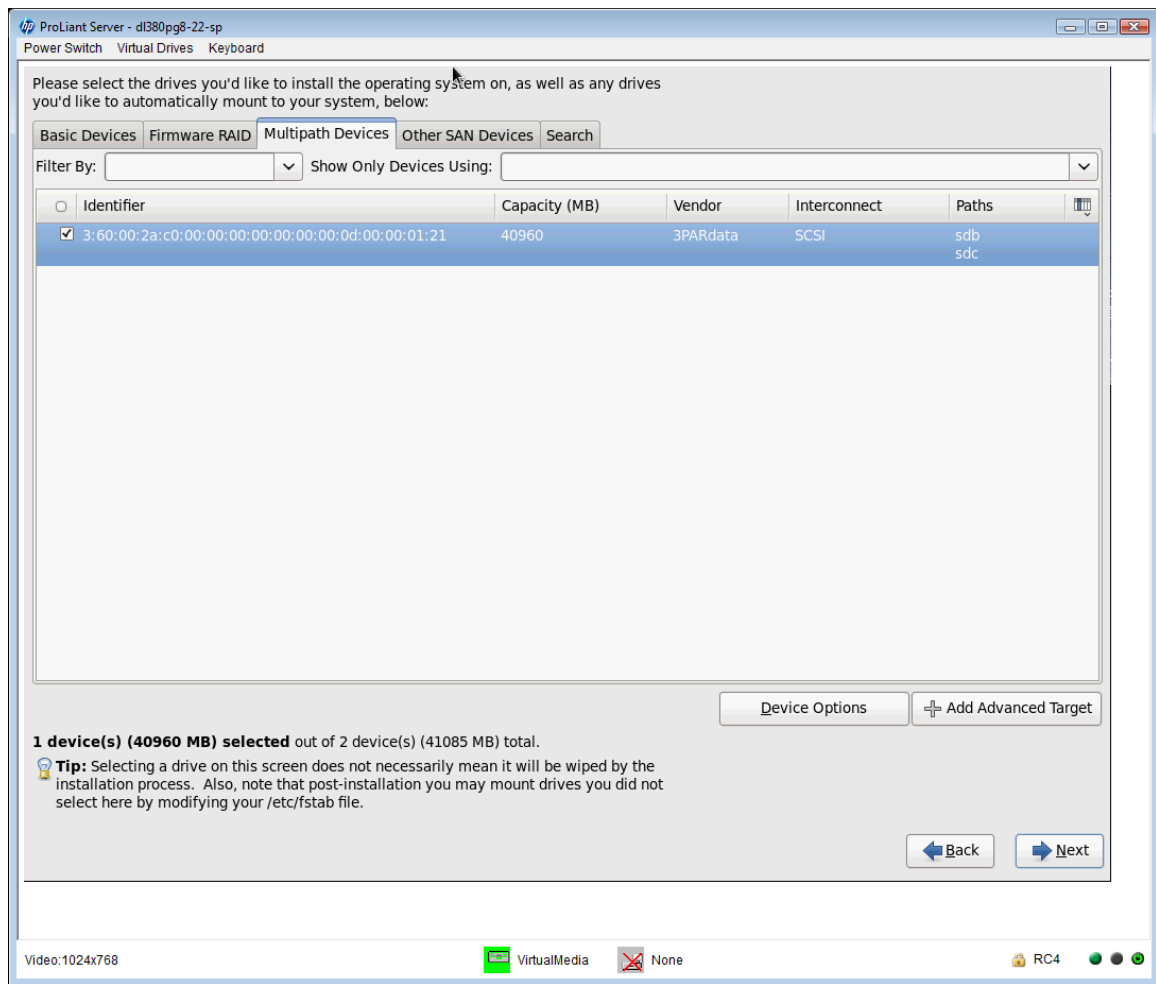
- "linux dd" can be used to load the driver disk source during the installation.
- A networking device, IP address, gateway, and DNS are also required during the install.
- Select **Specialized Storage Devices** to discover the iSCSI boot LUN. See [Figure 14 \(page 73\)](#).

**Figure 14 Specialized Storage Devices**



- Once the boot LUN is discovered, select the multipath devices to install the RHEL ([Figure 15 \(page 74\)](#)).

Figure 15 Multipath Devices



For more information, see the *RedHat Enterprise Linux 6 Storage Administration Guide*, available at the following website:

[Red Hat](http://www.redhat.com)

## Configuring RHEL 6 or RHEL 5 iSCSI Settings with Device-mapper Multipathing

The `/etc/multipath.conf` file is used by Device-mapper where the multipathing parameters have been set. The default installed `/etc/multipath.conf` file must be edited with the following changes for a minimum configuration connecting to an HP 3PAR array. Entries listed in `multipath.conf` override the default kernel parameters for `dm-multipath`. In general, the kernel defaults are sufficient with the exception of the devices entries for HP 3PAR.

**NOTE:** See RHEL documentation of DM Multipath Configuration and Administration for additional options in `multipath.conf` entries.

1. Remove or comment out all entries in the `/etc/multipath.conf` file except for the devices section of devices currently in use.
2. Edit the devices structure to add entries for HP 3PAR StoreServ Storage array and remove other product entries that are not needed.

For RHEL 6.2 or later

```
# cat /etc/multipath.conf
defaults {
```

```

        polling_interval      5
        max_fds               8192
    }

    devices {
        device {
            vendor              "3PARdata"
            product              "VV"
            no_path_retry       12
            features             "0"
            hardware_handler     "0"
            path_grouping_policy multibus
            path_selector         "round-robin 0"
            rr_weight             uniform
            rr_min_io_rq         1
            path_checker          tur
            failback              immediate
        }
    }
}

```

## For RHEL 6.1

```

# cat /etc/multipath.conf
defaults {
    polling_interval      5
}

devices {
    device {
        vendor              "3PARdata"
        product              "VV"
        no_path_retry       12
        features             "0"
        hardware_handler     "0"
        path_grouping_policy multibus
        path_selector         "round-robin 0"
        rr_weight             uniform
        rr_min_io            1
        path_checker          tur
        failback              immediate
    }
}

```

## For ALUA Settings in RHEL 6.1 or Later

```
# multipath.conf written by anaconda

defaults {
    user_friendly_names      no
    polling_interval         10
    max_fds                  8192
}
devices {
    device {
        vendor                "3PARdata"
        product               "VV"
        features              "0"
        hardware_handler      "1 alua"
        path_selector          "round-robin 0"
        getuid_callout         "/lib/udev/scsi_id --whitelisted --device=/dev/%n"
        path_grouping_policy   "group_by_prio"
        prio                  "alua"
        failback              "immediate"
        rr_weight              "uniform"
        no_path_retry          18
        rr_min_io_rq          1
        path_checker           "tur"
    }
}
```

## For RHEL 5.6 or Later

```
# cat /etc/multipath.conf
defaults {
    polling_interval         5
}
devices {
    device {
        vendor                "3PARdata"
        product               "VV"
        no_path_retry         12
        features              "0"
        hardware_handler      "0"
        path_grouping_policy   multibus
        path_selector          "round-robin 0"
        rr_weight              uniform
        rr_min_io             100
        path_checker           tur
        failback              immediate
    }
}
```

## For ALUA Settings in RHEL 5.8

```
# cat /etc/multipath.conf
defaults {
    user_friendly_names    no
    polling_interval       10
}
devices {
    device {
        vendor              "3PARdata"
        product             "VV"
        features            "0"
        path_grouping_policy "group_by_prio"
        path_selector        "round-robin 0"
        getuid_callout       "/sbin/scsi_id -g -u -s /block/%n"
        hardware_handler     "1 alua"
        prio_callout         "/sbin/mpath_prio_alua /dev/%n"
        failback            "immediate"
        rr_weight            "uniform"
        no_path_retry        18
        rr_min_io            100
        path_checker         "tur"
    }
}
```

## For RHEL 5.0 through RHEL 5.5

**NOTE:** The following multipath settings for the RHEL server apply regardless of the HP 3PAR OS version running on the HP 3PAR StoreServ Storage array with a persona 1 setting:

```
# cat /etc/multipath.conf
defaults {
}
devices {
    device {
        vendor              "3PARdata"
        product             "VV"
        no_path_retry        12
        features            "0"
        hardware_handler     "0"
        path_grouping_policy "multibus"
        path_selector        "round-robin 0"
        rr_weight            uniform
        rr_min_io            100
        path_checker         tur
        failback            immediate
        polling_interval     5
    }
}
```

If the HP 3PAR StoreServ Storage array that the RHEL server is connecting to is running an HP 3PAR OS version 3.1.3 or later, you must change the host persona to 2 (ALUA) and modify the `/etc/multipath.conf` file.

When changing from HP 3PAR host persona 1 to host persona 2 or vice versa:

- A change from persona 1 to persona 2, or from persona 2 to persona 1, requires that the array ports affected be taken offline, or that the host for which the persona is being changed be not connected (not logged in). This is an HP 3PAR OS requirement.
- For existing devices targeted in a persona to be claimed, the host must be rebooted.

Use the following procedure:

1. Stop all host I/O and modify the `/etc/multipath.conf` file on the RHEL host.
2. Shut down the host.
3. Change the host persona on the array.
4. Boot the host.
5. Verify that the target devices have been claimed properly and that the persona setting is correct.

In addition, a SAN boot configuration requires rebuilding of the ramdisk in order to take effect.

3. Restart the `multipathd` daemon for any changes to be effective.
4. Verify that the `multipathd` daemon is enabled by the `rc` script to run on every host boot up.

The following output shows that it is enabled for run-level 3, 4 and 5. Enable it appropriately for your configuration:

```
# chkconfig --list multipathd
multipathd 0:off 1:off 2:off 3:on 4:on 5:on 6:off
```

5. Check that the appropriate `rc` scripts have been created for each run level. The start number(s) may not match those shown here.

```
# ls /etc/rc3.d/*multi*
/etc/rc3.d/S13multipathd
# ls /etc/rc5.d/*multi*
/etc/rc5.d/S13multipathd
```

Alternatively, you can use the `chkconfig` command to enable multipathing if it is not enabled:

```
# chkconfig multipathd on
```

## Starting the iSCSI Daemon for RHEL 6 or RHEL 5

To start the iSCSI daemon for the RHEL host, complete the following steps:

1. To start the `open-iscsi` module, issue the following command:

```
# /etc/init.d/iscsi start
Starting iSCSI daemon:
[ OK ]
[ OK ]
```

2. You can check the state of the open-iSCSI service run level information with the `chkconfig` command. Run level 5 should be on.

```
# chkconfig --list | grep iscsi
iscsi 0:off 1:off 2:off 3:off 4:off 5:on 6:off
# chkconfig --list | grep iscsid
iscsid 0:off 1:off 2:off 3:off 4:off 5:on 6:off
```

To turn on iSCSI, use the following commands:

```
# chkconfig iscsi on
# chkconfig iscsid on
```

To verify iSCSI status:

```
# chkconfig --list iscsi
iscsi 0:off 1:off 2:off 3:on 4:on 5:on 6:off
# chkconfig --list iscsid
iscsid 0:off 1:off 2:off 3:on 4:on 5:on 6:off
```

3. Verify that the `iscsi` module is loaded.

```
# lsmod | grep iscsi

iscsi_tcp      56897 2
libiscsi       59329 2 ib_iser,iscsi_tcp
scsi_transport_iscsi 63569 4 ib_iser,iscsi_tcp,libiscsi
scsi_mod       184057 10
sg,ib_iser,iscsi_tcp,libiscsi,scsi_transport_iscsi,qla2xxx,lpfc,scsi_transport_fc,cciss,sd_mod
```

## Creating the Software iSCSI Connection in RHEL 6 or RHEL 5 Using the `iscsiadm` Command

**NOTE:** To set up a hardware iSCSI connection, see “Setting Up Hardware iSCSI for RHEL 6 or RHEL 5” (page 60).

After connecting the host to the HP 3PAR StoreServ Storage iSCSI target port, use the `iscsiadm` command to create the iSCSI connection, complete following steps:

1. Discover the target node using the `iscsiadm` command in discovery mode:

```
iscsiadm -m discovery -t sendtargets -p <target ip address>:<iscsi port>.
```

For example:

```
# iscsiadm -m discovery -t sendtargets -p 10.100.0.101:3260
10.100.0.101:3260,31 iqn.2000-05.com.3pardata:20310002ac000079
```

2. The contents of the discovery can be viewed using the `iscsiadm -m discovery` command.  
For example:

```
# iscsiadm -m discovery
10.100.0.101:3260 via sendtargets
```

3. Issue the `iscsiadm -m node` command:

```
# iscsiadm -m node
10.100.1.101:3260,31 iqn.2000-05.com.3pardata:20320002ac000121
```

4. Identify the iSCSI node login that record has been discovered from the discovery process.  
`iscsiadm -m node -T <targetname> -p <target ip address>:<iscsisport> -l.`

For example:

```
# iscsiadm -m node -T iqn.2000-05.com.3pardata:20310002ac000079 -p 10.100.0.101:3260 -l
Logging in to [iface: default, target: iqn.2000-05.com.3pardata:20310002ac000079, portal: 10.100.0.101,3260]
Login to [iface: default, target: iqn.2000-05.com.3pardata:20310002ac000079, portal: 10.100.0.101,3260]: successful
```

5. The content of the login node can be viewed using the `iscsiadm` command.  
For example:

```
# iscsiadm -m node -T iqn.2000-05.com.3pardata:20310002ac000079 -p 10.100.0.101:3260
10.100.0.101:3260,31 iqn.2000-05.com.3pardata:20310002ac000079
```

6. Now examine the iSCSI session and content session of the node info by issuing `iscsiadm -m session`.

For example:

```
# iscsiadm -m session
tcp: [1] 10.100.0.101:3260,31 iqn.2000-05.com.3pardata:20310002ac000079
```

See [“RHEL iscsiadm Utility Usage” \(page 24\)](#) for more RHEL `iscsiadm` command usage.

In RHEL 5.4, the open-iSCSI persistent configuration is implemented as a DBM database available during the Linux iSCSI installation.

- Discovery table (`/var/lib/iscsi/send_targets`)
- Node table (`/var/lib/iscsi/nodes`)

The following example shows settings for `send_targets` and `node` tables:

```
send_targets/
drw----- 2 root root 4096 Feb 26 16:51 10.102.2.131,3260
drw----- 2 root root 4096 Feb 26 10:22 10.102.2.31,3260
nodes/
drw----- 3 root root 4096 Feb 26 10:22 iqn.2000-05.com.3pardata:20310002ac0000b1
drw----- 3 root root 4096 Feb 26 10:58 iqn.2000-05.com.3pardata:21310002ac0000b1
```

To change or modify the `send_targets` or `nodes`, remove the above entry first to use the `iscsiadm` utility to add the new `send_targets` or `nodes`, after which the persistent tables will update.



---

**NOTE:** The RHEL 5 iSCSI iface setup describes how to bind a session to a NIC port using iSCSI software. Running `iscsiadm -m iface` reports iface configurations setup in `/var/lib/iscsi/ifaces`.

For more details, refer to the RHEL 5 U4 open-iscsi release note.

---

## Configuring RHEL 4 for iSCSI

This section discusses the necessary tasks for setting up iSCSI for RHEL 4.

### Installing iSCSI on RHEL 4

Install the software iSCSI initiator software package if it has not been installed. The software package can be installed from the respective Service Pack distribution CDs of your RHEL 4 OS version using the RPM tool.

### Setting Up a Software iSCSI for RHEL 4

Complete the following steps to setup the RHEL 4 iSCSI host:

1. Check state of the iSCSI service run level information with the `chkconfig` command.

```
# chkconfig --list | grep iscsi
iscsi 0:off 1:off 2:off 3:off 4:off 5:off 6:off
```

2. Check your system run level.

```
# runlevel
N 5
```

3. Configure the iSCSI service run level the same as your system run level and verify that the setting for the run level has changed. Now, every time you boot up the system, the iSCSI service will run.

```
# chkconfig --level 5 iscsi on
# chkconfig --list | grep iscsi
iscsi 0:off 1:off 2:on 3:on 4:on 5:on 6:off
```

4. Edit the `/etc/iscsi/iscsid.conf` file and at the end of the file add the following lines to configure the HP 3PAR StoreServ Storage iSCSI target port to connect to. In this example we are adding an iSCSI target port with an IP address of 10.0.0.10 and 10.0.0.20.

```
ConnFailTimeout=10
DiscoveryAddress=10.0.0.10
DiscoveryAddress=10.0.0.20
```

5. Reload the iSCSI service:

```
# /etc/init.d/iscsi reload
/etc/init.d/iscsi reload
```

---

**NOTE:** Dynamic Driver Reconfiguration: Configuration changes can be made to the iSCSI driver without having to stop it or to reboot the host system. To dynamically change the configuration of the driver, insert the `/etc/init.d/iscsi reload` to the `/etc/iscsi/iscsid.conf` file. This will cause the iSCSI daemon to re-read the `iscsi.conf` file and to create any new Discovery Address connections it finds. Those discovery sessions will then discover targets and create new target connections.

---

6. Make sure that the `multipathd` daemon is not running. If it is, you can stop it by running the script `/etc/init.d/multipathd stop`.

```
# /etc/init.d/multipathd status
multipathd is stopped
```

7. Verify that the module `iscsi_sfnet` is not loaded.

```
# lsmod | grep iscsi_sfnet
```

8. Verify that the module `iscsi_sfnet` has been loaded.

```
# lsmod | grep iscsi_sfnet
iscsi_sfnet 96093 26
scsi_transport_iscsi 14017 1 iscsi_sfnet
scsi_mod 145297 7
iscsi_sfnet,lpfc,libata,cciss,qla2xxx,scsi_transport_fc,sd_mod
```

## Configuring RHEL 4 iSCSI Settings with Device-mapper Multipathing

The `/etc/multipath.conf` file is used by Device-mapper where the multipathing parameters have been set. The default installed `/etc/multipath.conf` file must be edited with the following changes for a minimum configuration connecting to an HP 3PAR StoreServ Storage array. Entries listed in `multipath.conf` override the default kernel parameters for `dm-multipath`. In general, the kernel defaults are sufficient with the exception of the devices entries for HP 3PAR.

---

**NOTE:** See RHEL documentation of DM Multipath Configuration and Administration for additional options in `multipath.conf` entries.

**NOTE:** See “Setting Up Device-mapper” (page 48) for the installation of the Device-mapper rpm packages.

---

1. Remove or comment out all entries in the `/etc/multipath.conf` file except for the devices section of devices currently in use.
2. Edit the devices structure to add entries for HP 3PAR StoreServ Storage array and remove other product entries that are not needed.
3. Verify that the `/etc/multipath.conf` file contains the following content:

---

**NOTE:** The following multipath settings for the RHEL server apply regardless of the HP 3PAR OS version running on the HP 3PAR StoreServ Storage array.

---

```
# cat /etc/multipath.conf
defaults {
}

devices {
    device {
```

```

        vendor                "3PARdata"
        product                "VV"
        no_path_retry          12
        features                "0"
        hardware_handler        "0"
        path_grouping_policy    multibus
        path_selector            "round-robin 0"
        rr_weight                uniform
        rr_min_io               100
        path_checker            tur
        failback                 immediate
        polling_interval         5
    }
}

```

4. Run the `multipath` command for any name changes to be effective.
5. Verify that the `multipathd` daemon is enabled by the `rc` script to run on every host boot up.

The following output shows that it is enabled for run-level 3, 4 and 5. Enable it appropriately for your configuration.

```

# chkconfig --list multipathd
multipathd 0:off 1:off 2:off 3:on 4:on 5:on 6:off

```

6. Check that the appropriate `rc` scripts have been created for each run level. The start numbers may not match those shown here.

```

# ls /etc/rc3.d/*multi*
/etc/rc3.d/S13multipathd
# ls /etc/rc5.d/*multi*
/etc/rc5.d/S13multipathd

```

Alternatively, you can use the `chkconfig` command to enable multipathing if it is not enabled:

```

# chkconfig multipathd on

```

## Configuring CHAP for the iSCSI Host

Two CHAP authentication configurations are available: Host CHAP authentication, where the HP 3PAR StoreServ Storage iSCSI target port authenticates the iSCSI Initiator host when it tries to connect to it, and bidirectional (mutual) CHAP authentication, where both the iSCSI target and host authenticate each other when the host tries to connect to the target.

You must create an iSCSI host definition on the HP 3PAR StoreServ Storage before setting and configuring CHAP for the iSCSI host. See [“Creating the iSCSI Host Definition” \(page 21\)](#).

## Setting the Host CHAP Authentication on the HP 3PAR StoreServ Storage

To set the host CHAP authentication, an iSCSI host definition must have been created on the HP 3PAR StoreServ Storage, and the HP 3PAR OS CLI `sethost initchap` command must be used to set the host CHAP secret.

For HP 3PAR OS 3.1.x and OS 2.3.x, the output shows:

```
# showhost
Id Name          Persona -----WWN/iSCSI_Name----- Port
0 redhatlinux    Generic ign.1994-05.com.redhat:a3df53b0a32d ---
```

For HP 3PAR OS 2.2.x, the output shows:

```
# showhost
Id Name -----WWN/iSCSI_Name----- Port
0 linux         ign.1994-05.com.redhat:a3df53b0a32d --
                  ign.1994-05.com.redhat:a3df53b0a32d
```

The following example uses the host CHAP password `host_secret0` for the host. Be aware that CHAP secret must be at least 12 characters long.

- Set the host CHAP secret.

```
# sethost initchap -f host_secret0 redhatlinux
```

- Verify the host CHAP secret.

```
# showhost -chap
Id Name          -Initiator_CHAP_Name- -Target_CHAP_Name-
0 redhatlinux    redhatlinux         --
```

## Setting the Host CHAP for RHEL 6 or RHEL 5

To set the host CHAP for RHEL 6 or RHEL 5, complete the following steps:

1. Go to the iSCSI Initiator host console, or, at a terminal, edit the `/etc/iscsi/iscsid.conf` file and enable CHAP authentication:

```
#To enable CHAP authentication set node.session.auth.authmethod
#to CHAP. The default is None.
node.session.auth.authmethod = CHAP
```

2. Configure the host CHAP password for the discovery and login session by again editing the configuration file `/etc/iscsi/iscsid.conf` file.

```
#To set a discovery session CHAP username and password for the initiator
#authentication by the target(s), uncomment the following lines:
discovery.sendtargets.auth.username = redhatlinux
discovery.sendtargets.auth.password = host_secret0
#To set a CHAP username and password for initiator
#authentication by the target(s), uncomment the following lines:
node.session.auth.username = redhatlinux
node.session.auth.password = host_secret0
```

**NOTE:** The `OutgoingUsername` variable can be set to anything you want, but the `OutgoingPassword` has to be the same as the host CHAP secret configured on the HP 3PAR StoreServ Storage.

3. Perform discovery and login as described in [“Discovering Devices with a Software iSCSI Connection” \(page 112\)](#).

If the targets have been discovered previously, you must logout of the iSCSI sessions, delete the node and send target records before performing discovery and logins by completing the following steps:

- a. Perform an iSCSI Logout:

```
# iscsiadm -m node --logoutall=all
```

- b. Remove the iSCSI Node:

```
# iscsiadm -m node -o delete -T ign.2000-05.com.3pardata:20310002ac000079 -p 10.100.0.101,3260
```

- c. Remove iSCSI targets:

```
# iscsiadm -m discovery -o delete -p 10.100.0.101
```

- d. Stop and start the iSCSI daemon:

```
# /etc/init.d/iscsid stop
Stopping iSCSI daemon:
# /etc/init.d/iscsid start
Turning off network shutdown. Starting iSCSI daemon: [ OK ]
[ OK ]
```

- e. Repeat the steps as described in [“Creating the Software iSCSI Connection in RHEL 6 or RHEL 5 Using the iscsiadm Command” \(page 79\)](#) to rediscover the iSCSI target nodes and create the iSCSI login sessions.

## Setting the Host CHAP for RHEL 4

To set the host CHAP for RHEL 4, complete the following steps:

1. Go to the iSCSI Initiator host console, or, at a terminal, edit the `/etc/iscsi/iscsid.conf` file and configure the host CHAP password.

```
DiscoveryAddress=10.0.0.10
DiscoveryAddress=10.0.0.20
OutgoingUsername=redhatlinux
OutgoingPassword=host_secret0
```

**NOTE:** You must have the `OutgoingUsername` and `OutgoingPassword` variables under the `DiscoveryAddress` variable.

**NOTE:** The `OutgoingUsername` variable can be set to anything you want, but the `OutgoingPassword` has to be the same as the host CHAP secret configured on the HP 3PAR StoreServ Storage.

2. Check to see if the `iscsid` daemon is running by using the script `/etc/init.d/iscsi status`.

```
# /etc/init.d/iscsi status
iscsid (pid 30532 30529) is running... (RedHat 4)
Checking for service iSCSI driver is loaded
```

## Setting Up the Bidirectional CHAP on the HP 3PAR StoreServ Storage

To set bidirectional CHAP (mutual), complete the following steps. The HP 3PAR OS CLI `sethost initchap` and `sethost targetchap` commands must be used to set bidirectional CHAP on the HP 3PAR StoreServ Storage.

1. Verify that a host definition has been created on the HP 3PAR StoreServ Storage. The following example uses `host_secret0` for the host CHAP password and `target_secret0` for the target CHAP password.

For HP 3PAR OS 3.1.x or OS 2.3.x, the output shows:

```
# showhost
Id Name          Persona -----WWN/iSCSI_Name----- Port
0 redhatlinux    Generic iqn.1994-05.com.redhat:a3df53b0a32d ---
```

For HP 3PAR OS 2.2.x, the `showhost` command shows the host definition on the HP 3PAR StoreServ Storage for the iSCSI host:

```
# showhost
Id Name -----WWN/iSCSI_Name----- Port
0 linux  iqn.1994-05.com.redhat:a3df53b0a32d  --
          iqn.1994-05.com.redhat:a3df53b0a32d  --
```

**NOTE:** The following example uses the host CHAP password `host_secret0` for the host. Be aware that CHAP secret must be at least 12 characters long.

2. Set the host CHAP secret.

```
# sethost initchap -f host_secret0 redhatlinux
```

3. Set the target CHAP secret.

```
# sethost targetchap -f target_secret0 redhatlinux
```

4. Verify the host and target CHAP secret.

```
# showhost -chap
Id Name          -Initiator_CHAP_Name- -Target_CHAP_Name-
0 redhatlinux    redhatlinux        S121
```

## Setting the Bidirectional CHAP for RHEL 6 or RHEL 5

To configure the bidirectional CHAP for RHEL 6 or RHEL 5, go to the iSCSI Initiator host console, or, at a terminal, edit the `/etc/iscsi/iscsid.conf` and configure the host and target CHAP passwords for discovery and login sessions by completing the following steps.

---

**NOTE:** Notice that two `DiscoveryAddress` variables with the same IP address for the HP 3PAR StoreServ Storage iSCSI target port are required. One for the host CHAP username and password variables (`OutgoingUsername` and `OutgoingPassword`) and another one for target CHAP username and password variables (`IncomingUsername` and `IncomingPassword`).

---

1. Perform the CHAP configuration settings for the host initiator:

```
# To enable CHAP authentication set node.session.auth.authmethod
# to CHAP. The default is None.
node.session.auth.authmethod = CHAP

# To set a discovery session CHAP username and password for the initiator
# authentication by the target(s), uncomment the following lines:
discovery.sendtargets.auth.username = redhatlinux
discovery.sendtargets.auth.password = host_secret0

# To set a CHAP username and password for initiator
# authentication by the target(s), uncomment the following lines:
node.session.auth.username = redhatlinux
node.session.auth.password = host_secret0
```

2. Perform the CHAP configuration settings for the target:

```
#To set a discovery session CHAP username and password for target(s)
# authentication by the initiator, uncomment the following lines:
discovery.sendtargets.auth.username_in = S121
discovery.sendtargets.auth.password_in = target_secret0

# To set a CHAP username and password for target(s)
# authentication by the initiator, uncomment the following lines:
node.session.auth.username_in = S121
node.session.auth.password_in = target_secret0
# To enable CHAP authentication for a discovery session to the target
# set discovery.sendtargets.auth.authmethod to CHAP. The default is None.
discovery.sendtargets.auth.authmethod = CHAP
```

---

**NOTE:** S121 is the target CHAP name, which can be displayed on the HP 3PAR StoreServ Storage by running the command `showhost -chap`.

**NOTE:** The `OutgoingUsername` and `IncomingUsername` variables can be set to anything you want, but the `OutgoingPassword` and `IncomingPassword` must match the host CHAP password and target CHAP password configured on the HP 3PAR StoreServ Storage.

---

3. Perform discovery and login as describe in [“Discovering Devices with a Software iSCSI Connection”](#) (page 112).

If the targets have been discovered previously, you must logout of the iSCSI sessions, delete the node and send target records before performing discovery and logins by completing the following steps:

- a. Perform an iSCSI Logout.

```
# iscsiadm -m node --logoutall=all
```

- b. Remove the iSCSI Node.

```
# iscsiadm -m node -o delete -T ign.2000-05.com.3pardata:20310002ac000079 -p 10.100.0.101,3260
```

- c. Remove iSCSI targets.

```
# iscsiadm -m discovery -o delete -p 10.100.0.101
```

- d. Stop and start the iSCSI daemon.

```
# /etc/init.d/iscsid stop
Stopping iSCSI daemon:
# /etc/init.d/iscsid start
Turning off network shutdown. Starting iSCSI daemon: [ OK ]
[ OK ]
```

- e. Make sure to remove the iSCSI persistent files under these directories:

```
/var/lib/iscsi/send_targets/
/var/lib/iscsi/nodes/
```

For example:

```
# ls -l /var/lib/iscsi/send_targets/*
# ls -l /var/lib/iscsi/nodes/*
# rm -rf /var/lib/iscsi/send_targets/*
# rm -rf /var/lib/iscsi/nodes/*
```

- f. Repeat the steps as described in [“Creating the Software iSCSI Connection in RHEL 6 or RHEL 5 Using the iscsiadm Command”](#) (page 79) to rediscover the iSCSI target nodes and create the iSCSI login sessions.

## Setting the Bidirectional CHAP for RHEL 4

To configure the bidirectional CHAP for RHEL 4, complete the following steps.



1. Go to the iSCSI Initiator host console, or, at a terminal, edit the `/etc/iscsi/iscsid.conf` file and configure the host and target CHAP passwords.

```
DiscoveryAddress=10.0.0.10
DiscoveryAddress=10.0.0.20
    OutgoingUsername=redhatlinux
    OutgoingPassword=host_secret0
DiscoveryAddress=10.0.0.10
DiscoveryAddress=10.0.0.20
    IncomingUsername=S4121
    IncomingPassword=target_secret0
```

**NOTE:** Notice that two `DiscoveryAddress` variables with the same IP address for the HP 3PAR StoreServ Storage iSCSI target port are required: one for the host CHAP username and password variables (`OutgoingUsername` and `OutgoingPassword`) and another one for target CHAP username and password variables (`IncomingUsername` and `IncomingPassword`).

**NOTE:** You can choose the `OutgoingUsername` and `IncomingUsername` variables, but the `OutgoingPassword` and `IncomingPassword` must match the host CHAP password and target CHAP password configured on the HP 3PAR StoreServ Storage.

### Required

The variables under the `DiscoveryAddress` variable must be offset with a space in order for the variables not to be global and to apply only to the specific `DiscoveryAddress` above them.

2. Start or restart the `iscsid` daemon with the script `/etc/init.d/iscsi`.
3. Check to see if the `iscsid` daemon is running by using the script `/etc/init.d/iscsi status`.

```
# /etc/init.d/iscsi status
iscsid (pid 30532 30529) is running... (RedHat 4)
Checking for service iSCSI iSCSI driver is loaded
```

**NOTE:** RHEL has documented a bug that can prevent an iSCSI host from rebooting (bug# 583218). RHEL has published a patch for the bug at the following location:

[Red Hat](#)

## Configuring and Using Internet Storage Name Server

A dedicated IP network is preferable in configuring Internet Storage Name Server (iSNS).

**NOTE:** Secondary iSNS servers are not supported.

DHCP is not supported on iSCSI configurations.

### Using a Microsoft iSNS Server to Discover Registrations

A Microsoft iSNS Server can be used to discover the iSCSI initiator and iSCSI targets on a dedicated network.

Use the Windows 2008 Add Features wizard to add the iSNS feature, and then use the iSNS to discover registrations.

## Using the iSNS Server to Create a Discovery Domain

Follow these steps:

1. Click **Start**→**Administrative Tools**→**iSNS Server**→**Discovery Domains** tab.
2. In the window that appears, click the **Create** button.
3. In the **Create Discovery Domain** popup, enter the discovery domain or select the default, and then click **OK**.

## Configuring the iSCSI Initiator and Target for iSNS Server Usage

### Configuring the HP 3PAR StoreServ Storage

Follow these steps to configure the HP 3PAR StoreServ Storage:

1. Issue the `showport -iscsi` command to verify whether the iSCSI target ports are configured for the iSNS server. For example:

```
root@snodeda66:S66# showport -iscsi
N:S:P      State  IPAddr      Netmask      Gateway      TPGT MTU Rate  DHCP iSNS_Prim iSNS_Sec  iSNS_Port
0:3:1      offline 0.0.0.0      0.0.0.0      0.0.0.0      31   1500 n/a    0     0.0.0.0   0.0.0.0   3205
0:3:2      ready   10.107.66.3  255.255.255.0 10.107.66.3  32   1500 1Gbps  0     0.0.0.0   0.0.0.0   3205
1:3:1      offline 0.0.0.0      0.0.0.0      0.0.0.0      131  1500 n/a    0     0.0.0.0   0.0.0.0   3205
1:3:2      ready   10.107.66.8  255.255.255.0 10.107.66.8  132  1500 1Gbps  0     0.0.0.0   0.0.0.0   3205
-----
```

2. Set up the IP addresses for iSNS.

```
# controliscsiport isns <iSNS Server IP><HP 3PAR StoreServ Storage iSCSI port>
```

Example:

```
# controliscsiport isns 10.107.66.11 0:3:2
# controliscsiport isns 10.107.66.11 1:3:2
```

3. Verify the configuration setting for iSNS. For example:

```
# showport -iscsi
N:S:P      State  IPAddr      Netmask      Gateway      TPGT MTU Rate  DHCP iSNS_Addr iSNS_Port
0:3:1      ready   10.100.0.101 255.255.0.0  0.0.0.0      31   1500 10Gbps 0     0.0.0.0   0.0.0.0   3205
0:3:2      loss_sync 0.0.0.0      0.0.0.0      0.0.0.0      32   1500 n/a    0     0.0.0.0   0.0.0.0   3205
1:3:1      ready   10.100.0.201 255.255.0.0  0.0.0.0      131  1500 10Gbps 0     0.0.0.0   0.0.0.0   3205
1:3:2      loss_sync 0.0.0.0      0.0.0.0      0.0.0.0      132  1500 n/a    0     0.0.0.0   0.0.0.0   3205
-----
4
```

### Configuring the iSNS Client (RHEL Host)

Install the `isns-utils` package using `yum`.

```
# yum --nogpgcheck install isns-utils
```

Switch the service on by issuing the following command:

```
# chkconfig isnsd on
```

Start the service by issuing the following command:

```
# service isnsd start
```

Create a new ISNS interface by issuing the following command

```
# iscsiadm -m iface -o new -I isns_iface
```

Update the interface to use TCP/IP by issuing the following command:

```
# iscsiadm -m iface -o update -I isns_iface -n iface.transport_name -v tcp
```

Discover the ISNS server by issuing the following commands.

Example:

```
# iscsiadm -m discoverydb -t isns -p <ISNS server IP> : <port> -o new
# iscsiadm -m discoverydb -t isns -p 10.107.66.11:3205 -o update -n
discovery.isns.use_discoveryd -v Yes
```

Edit the file `/var/lib/iscsi/isns/<ISNS server IP>,<port>/isns_config` and set the polling interval to 30:

```
# vi /var/lib/iscsi/isns/10.107.66.11,3205/isns_config
```

Restart the iSCSI service by issuing the following command:

```
# service iscsid restart
```

Restart the iSNS service by issuing the following command

```
# service isnsd restart
```

Confirm the configuration. For example:

```
# iscsiadm -m session
tcp: [5] 10.107.66.3:3260,1 iqn.2000-05.com.3pardata:20320002ac000042
tcp: [6] 10.107.66.8:3260,1 iqn.2000-05.com.3pardata:21320002ac000042
root@snoded9d7:S66# showhost
Id Name Persona -----WWN/iSCSI_Name----- Port
0 dl360g7-02 Generic iqn.1994-05.com.redhat:78fda13ee0 1:3:2
iqn.1994-05.com.redhat:78fda13ee0 0:3:2
1 dl360g7-06 Generic iqn.1994-05.com.redhat:b30e74ebc17 1:3:2
iqn.1994-05.com.redhat:b30e74ebc17 0:3:2
root@snoded9d7:S66# showport -iscsi
N:S:P State IPAddr Netmask Gateway TPGT MTU Rate DHCP iSNS_Prim iSNS_Sec iSNS_Port
0:3:1 offline 0.0.0.0 0.0.0.0 0.0.0.0 31 1500 n/a 0 0.0.0.0 0.0.0.0 3205
0:3:2 ready 10.107.66.3 255.255.255.0 10.107.66.3 32 1500 1Gbps 0 10.107.66.11 0.0.0.0 3205
1:3:1 offline 0.0.0.0 0.0.0.0 0.0.0.0 131 1500 n/a 0 0.0.0.0 0.0.0.0 3205
1:3:2 ready 10.107.66.8 255.255.255.0 10.107.66.8 132 1500 1Gbps 0 10.107.66.11 0.0.0.0 3205
-----
```

---

## 7 Configuring a Host with FCoE

This chapter describes the procedures that are required to set up a Linux host to communicate with an HP 3PAR StoreServ Storage server over an FCoE initiator on a Linux host to a FCoE target on the HP 3PAR StoreServ Storage server.

### Linux Host Requirements

The Linux host needs to meet the following software requirements. For specific details of supported configurations, consult the HP SPOCK website:

[HP SPOCK](#)

- Obtain the supported level of HBA BIOS and firmware from: [HP Service Pack for ProLiant](#)
- Obtain the supported level of HBA drivers from the following website:  
[HP Support](#)
- Install the Emulex OneCommand Manager: (`/usr/sbin/ocmanager/hbacmd`) or the QLogic QConvergeConsole Manager (`/opt/QLogic_Corporation/QConvergeConsoleCLI/qauccli`) for helping with setting up FCoE configurations. Visit the vendors's websites for download instructions.

### Configuring the FCoE Switch

Connect the RHEL (FCoE Initiator) host ports and HP 3PAR StoreServ Storage server (FCoE target) ports to an FCoE-enabled switch.

---

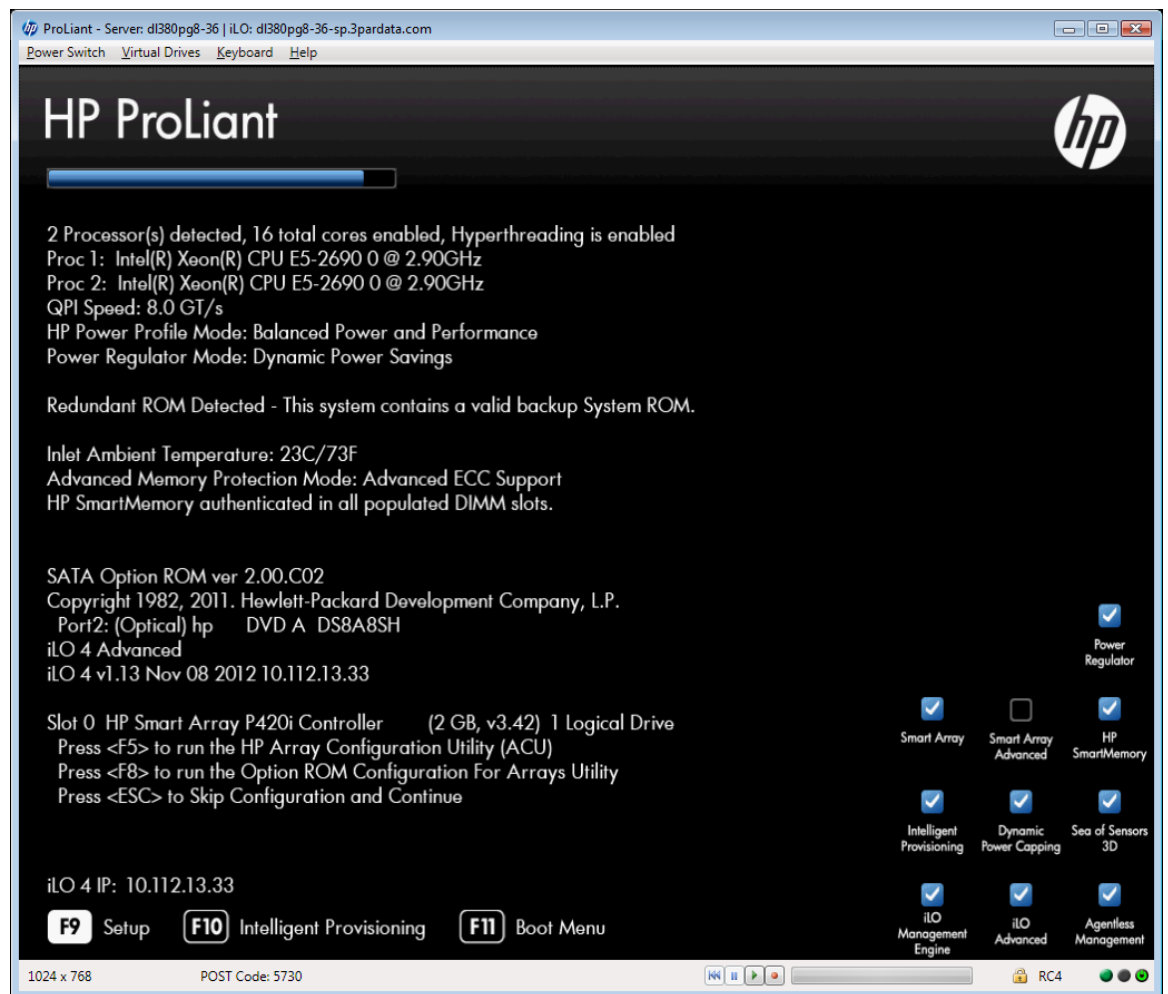
**NOTE:** FCoE switch VLANs and routing setup and configuration is beyond the scope of this document. Consult your switch manufacturer's documentation for instructions of how to set up VLANs and routing.

---

### Using system BIOS to configure FCoE

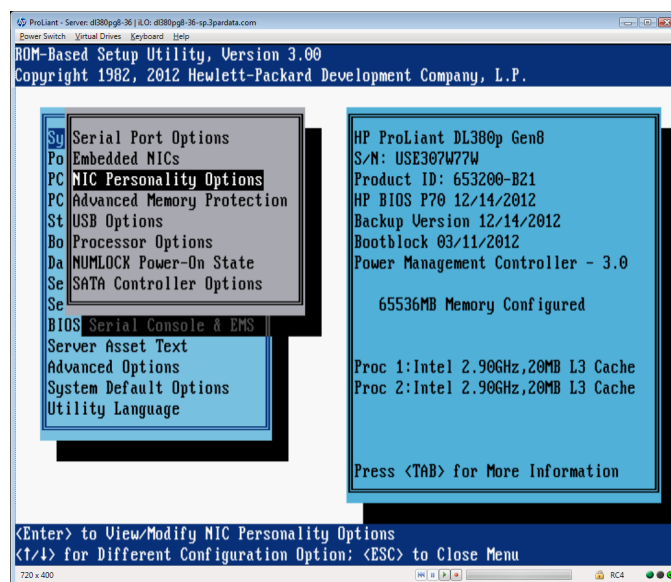
1. Using the system BIOS, configure FCoE. In this example, F9 was pressed to enter the Setup menu:

Figure 16 Configuring FCoE



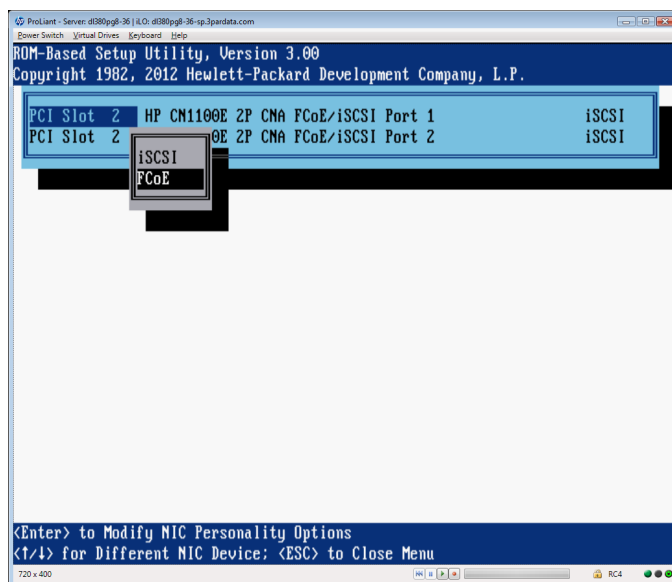
2. In the **System Options** pane, select **NIC Personality Options**.

Figure 17 NIC Personality Options



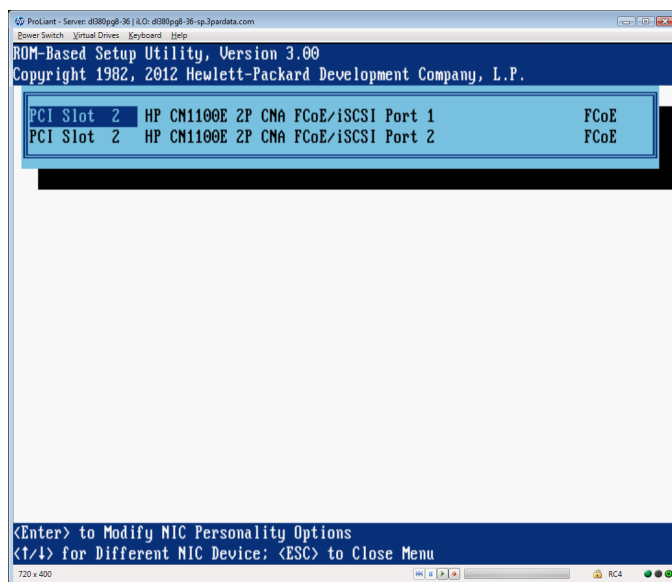
3. In the **PCI Slot 2** Pane, select **FCoE** for both **Port 1** and **Port 2**.

Figure 18 Configuring the PCI Slots



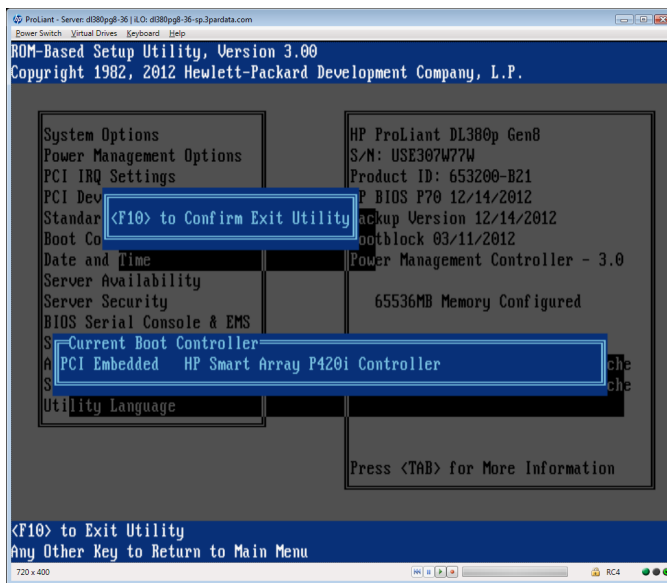
4. PCI Slot 2 Port 1 and Port 2 now display FCoE.

Figure 19 PCI Slot 1 and Slot 2 Configured for FCoE



5. Save the changes and exit the BIOS.

Figure 20 Exiting the BIOS Utility



## Configuring the FCoE host personality on Broadcom CNA

To configure the FCoE host personality on Broadcom CNA, follow these steps:

1. When the Broadcom BIOS message (shown in [Figure 21 \(page 95\)](#)) appears, enter **Ctrl-S**.

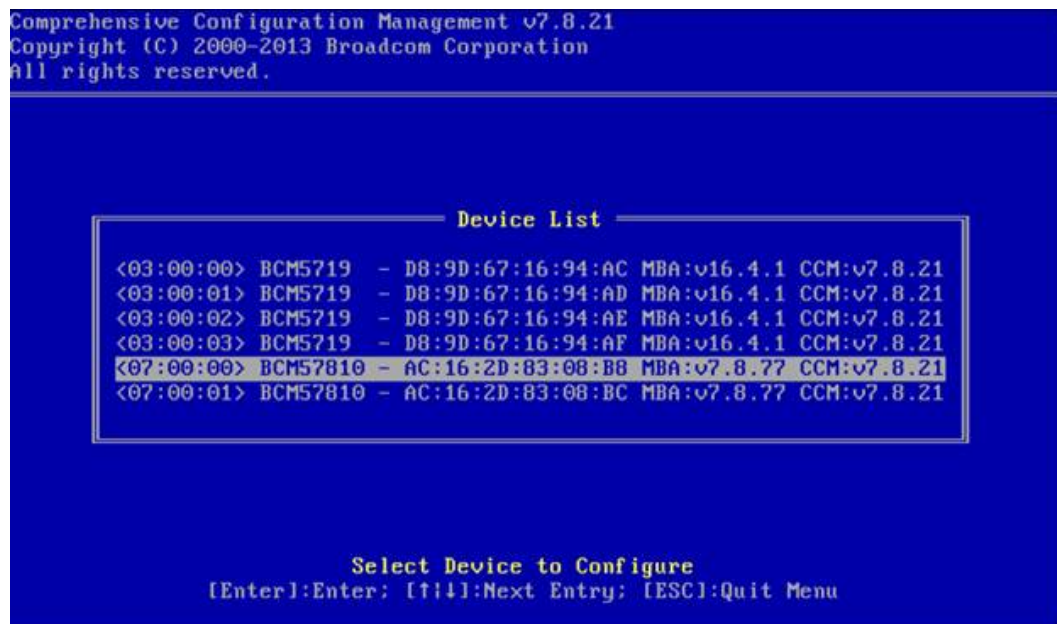
Figure 21 HP ProLiant Broadcom BIOS Message



The **Comprehensive Configuration Management** window appears.

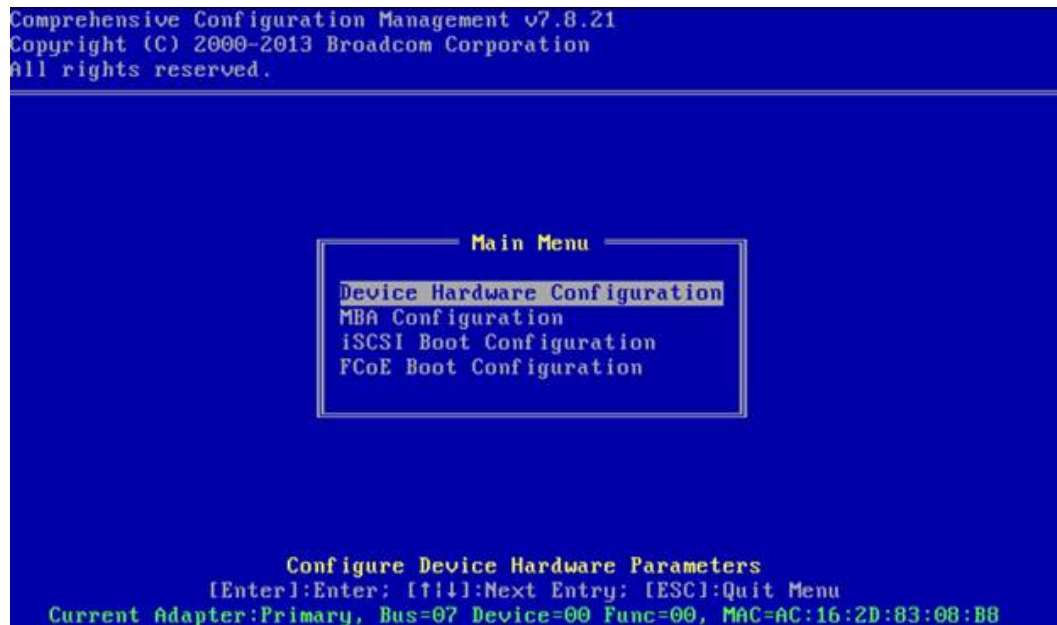
2. Select the appropriate device, as shown in [Figure 22 \(page 96\)](#).

Figure 22 Select the Appropriate Device



3. Select **Device Hardware Configuration**, as shown in Figure 23 (page 96).

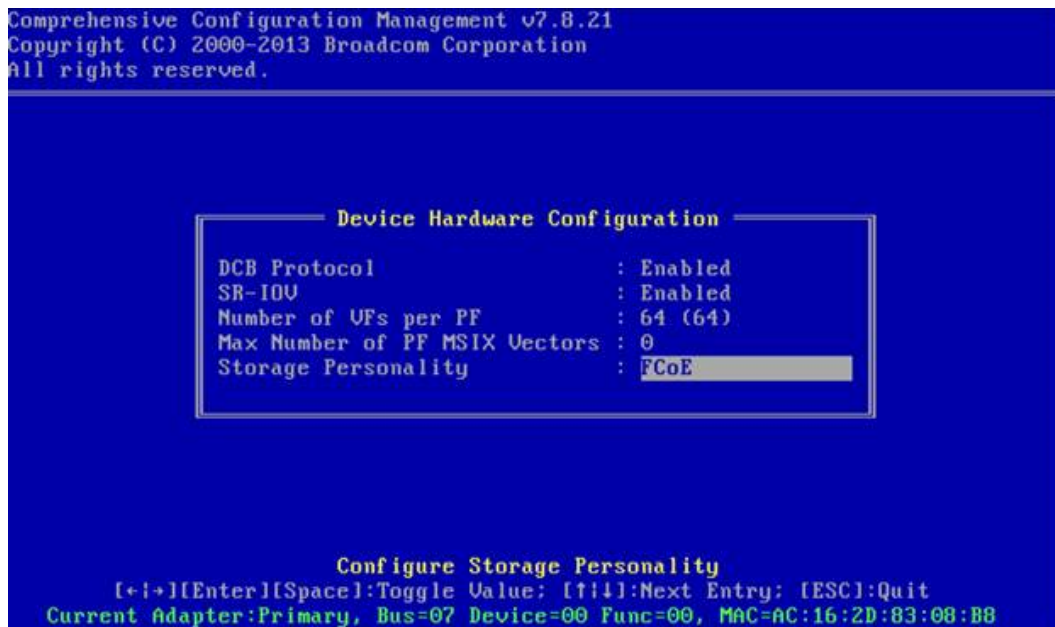
Figure 23 Select Device Hardware Configuration



4. Set **Storage Personality** to **FCoE**, as shown in Figure 24 (page 97).



**Figure 24 Set Storage Personality to FCoE**



## Installing and Configuring the Broadcom HBA for FCoE Connectivity

Install the Broadcom HBA(s) in the host in accordance with the documentation provided with the HBAs and host.

**NOTE:** Supported Servers

- Gen 8 only
- Most Gen 8 DL, BL and select ML Servers are supported; see server quick specs for specifics.
  - DL160 Gen8 ML350p Gen8 BL420c Gen8
  - DL360p Gen8 ML350e Gen8 BL460c Gen8
  - DL360e Gen8 BL660c Gen8
  - DL380e Gen8
  - DL380p Gen8
  - DL560 Gen8

## Building the Broadcom Driver

To build the Broadcom driver, follow these steps:

1. Download the driver package from the following website:  
[HP Support](#)
2. Extract the driver contents and follow the provided README to install the driver.

## Initializing and Configuring Broadcom FCoE

To initialize and configure the Broadcom FCoE, follow these steps:

1. Install the driver package.
2. Install the FCoE-utils package
3. Reboot the server.

- Find the FCoE Ethernet instances using ifconfig or the Network Manager on the GUI.

```
# ifconfig
eth6      Link encap:Ethernet  HWaddr AC:16:2D:83:08:BC
          inet addr:10.102.0.10  Bcast:10.102.255.255  Mask:255.255.0.0
          inet6 addr: fe80::ae16:2dff:fe83:8bc/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:15271 errors:0 dropped:0 overruns:0 frame:0
          TX packets:17 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:1245219 (1.1 MiB)  TX bytes:2738 (2.6 KiB)
          Interrupt:28 Memory:f4800000-f4ffffff

eth7      Link encap:Ethernet  HWaddr AC:16:2D:83:08:B8
          inet addr:10.102.0.12  Bcast:10.102.255.255  Mask:255.255.0.0
          inet6 addr: fe80::ae16:2dff:fe83:8b8/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:15271 errors:0 dropped:0 overruns:0 frame:0
          TX packets:16 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:1247133 (1.1 MiB)  TX bytes:2660 (2.5 KiB)
          Interrupt:26 Memory:f6000000-f67fffff
```

- Create configuration files for all FCoE ethX interfaces:

```
# cd /etc/fcoe
# cp cfg-ethx cfg-<ethX FCoE interface name>
```

- Modify /etc/fcoe/cfg-<interface> by setting DCB\_REQUIRED to yes and DCB\_REQUIRED to no. For example:

```
# cat /etc/fcoe/cfg-eth6
## Type:      yes/no
## Default:   no
# Enable/Disable FCoE service at the Ethernet port
# Normally set to "yes"
FCOE_ENABLE="yes"

## Type:      yes/no
## Default:   no
# Indicate if DCB service is required at the Ethernet port
# Normally set to "yes"
DCB_REQUIRED="no"

## Type:      yes/no
## Default:   no
# Indicate if VLAN discovery should be handled by fcoemon
# Normally set to "yes"
AUTO_VLAN="yes"
```

- Turn on all ethX interfaces

```
# ifconfig <ethX> up
```

- Disable lldpad on Broadcom CNA interfaces.

```
# lldptool set-lldp -i <ethX> adminStatus=disabled
```

9. Make sure that `/var/lib/llddpad/llddpad.conf` is created, and that each `<ethX>` block either does not specify `adminStatus` or is set to 0.
10. Restart lldpad service to apply new settings:

```
# service lldpad restart
```

11. Restart FCoE service to apply new settings:

```
# service fcoe restart
```

12. To verify all created FCoE interfaces, issue the `fcoeadm -I` command:

```
# fcoeadm -l
Interface:      eth6.2-fcoe
Roles:          FCP Target
Node Name:      0x2FF70002AC00011F
Port Name:      0x20010002AC00011F
Target ID:      0
MaxFrameSize:   2048
OS Device Name: rport-8:0-5
FC-ID (Port ID): 0x580BC0
State:          Online

Interface:      eth6.2-fcoe
Roles:          FCP Target
Node Name:      0x2FF70002AC00011F
Port Name:      0x21010002AC00011F
Target ID:      1
MaxFrameSize:   2048
OS Device Name: rport-8:0-6
FC-ID (Port ID): 0x580BA0
State:          Online
```

If no FCoE interfaces are present, then ensure that operating system is configured to automatically enable the required network interfaces.

For additional information, see the driver release notes on the HP Support website:

[HP Support](#)

## Configuring RHEL 6 FCoE Settings with Device-mapper Multipathing

The `/etc/multipath.conf` file is used by Device-mapper where the multipathing parameters have been set. The default installed `/etc/multipath.conf` file must be edited with the following changes for a minimum configuration connecting to an HP 3PAR StoreServ Storage array. Entries listed in `multipath.conf` override the default kernel parameters for `dm-multipath`. In general, the kernel defaults are sufficient with the exception of the devices entries for HP 3PAR.

**NOTE:** See RHEL documentation of DM Multipath Configuration and Administration for additional options in `multipath.conf` entries.

1. Remove or comment out all entries in the `/etc/multipath.conf` file except for the devices section of devices currently in use.
2. Edit the devices structure to add entries for HP 3PAR array and remove other product entries that are not needed.

**NOTE:** The following multipath settings for the RHEL server apply regardless of the HP 3PAR OS version running on the HP 3PAR StoreServ Storage array.

## For Broadcom FCoE and the ALUA Setting in RHEL 6.3 or Later

```
# cat /etc/multipath.conf
defaults {
    polling_interval    10
    max_fds             8192
}
devices {
    device {
        vendor          "3PARdata"
        product          "VV"
        path_grouping_policy "group_by_prio"
        getuid_callout    "/lib/udev/scsi_id --whitelisted --device=/dev/%n"
        path_selector     "round-robin 0"
        path_checker      "tur"
        features          "0"
        hardware_handler  "1 alua"
        prio              "alua"
        failback          "immediate"
        rr_weight         "uniform"
        no_path_retry     18
        rr_min_io         100
        fast_io_fail_tmo  10
        dev_loss_tmo      14
    }
}
```

## For RHEL 6.2 or Later

```
# cat /etc/multipath.conf
defaults {
    polling_interval    10
    max_fds             8192
}
devices {
    device {
        vendor          "3PARdata"
        product          "VV"
        no_path_retry   18
        features         "0"
        hardware_handler "0"
        path_grouping_policy multibus
        getuid_callout    "/lib/udev/scsi_id --whitelisted --device=/dev/%n"
        path_selector     "round-robin 0"
        rr_weight         uniform
        rr_min_io_rq      1
        path_checker      tur
        ailback           immediate
    }
}
```

## For the ALUA Setting in RHEL 6.2 or Later

```
# cat /etc/multipath.conf
defaults {
    polling_interval    10
    max_fds             8192
}
devices {
    device {
        vendor          "3PARdata"
        product          "VV"
        path_grouping_policy "group_by_prio"
        getuid_callout    "/lib/udev/scsi_id --whitelisted --device=/dev/%n"
        path_selector     "round-robin 0"
        path_checker      "tur"
        features          "0"
        hardware_handler   "1 alua"
        prio              "alua"
        failback          "immediate"
        rr_weight          "uniform"
        no_path_retry     18
        rr_min_io         100
    }
}
```

## For the ALUA Setting in RHEL 5.10 or later

```
# cat /etc/multipath.conf
defaults {
    polling_interval    10
}
devices {
    device {
        vendor          "3PARdata"
        product          "VV"
        features          "0"
        path_selector     "round-robin 0"
        getuid_callout    "/sbin/scsi_id -g -u -s /block/%n"
        hardware_handler   "1 alua"
        path_grouping_policy "group_by_prio"
        prio_callout       "/sbin/mpath_prio_alua /dev/%n"
        failback          "immediate"
        rr_weight          "uniform"
        no_path_retry     18
        rr_min_io         100
        path_checker      "tur"
    }
}
```

3. Restart the multipathd daemon for any changes to be effective.
4. Verify that the multipathd daemon is enabled by the rc script to run on every host boot up.  
The following output shows that it is enabled for run-level 3, 4 and 5. Enable it appropriately for your configuration:

```
# chkconfig --list multipathd
multipathd 0:off 1:off 2:off 3:on 4:on 5:on 6:off
```

5. Check that the appropriate rc scripts have been created for each run level. The start number(s) may not match those shown here.

```
# ls /etc/rc3.d/*multi*  
/etc/rc3.d/S13multipathd  
# ls /etc/rc5.d/*multi*  
/etc/rc5.d/S13multipathd
```

Alternatively, you can use the `chkconfig` command to enable multipathing if it is not enabled:

```
# chkconfig multipathd on
```

## 8 Allocating Storage for Access by the RHEL Host

### Creating Storage on the HP 3PAR StoreServ Storage

This section describes the general steps and commands that are required to create the virtual volumes (VVs) that can then be exported for discovery by the RHEL host.

For additional information, see the *HP 3PAR Command Line Interface Administrator's Manual*. For a comprehensive description of HP 3PAR OS commands, see the *HP 3PAR Command Line Interface Reference*. To obtain a copy of this documentation, go to the HP Support website:

[HP Support Center](#)

### Creating Virtual Volumes

Virtual volumes are the only data layer visible to hosts. After devising a plan for allocating space for hosts on the HP 3PAR StoreServ Storage, create the virtual volumes.

After devising a plan for allocating space for the RHEL host, you need to create the required virtual volumes on the HP 3PAR StoreServ Storage.

You can create volumes that are provisioned from one or more common provisioning groups (CPGs). Volumes can be fully provisioned from a CPG or can be thinly provisioned. You can optionally specify a CPG for snapshot space for fully-provisioned volumes.

Using the HP 3PAR Management Console:

1. From the menu bar, select:  
**Actions**→**Provisioning**→**Virtual Volume**→**Create Virtual Volume**
2. Use the **Create Virtual Volume** wizard to create a base volume.
3. Select one of the following options from the **Allocation** list:
  - **Fully Provisioned**
  - **Thinly Provisioned**

Using the HP 3PAR OS CLI:

To create a fully-provisioned or thinly-provisioned virtual volume, issue the following HP 3PAR OS CLI command:

```
# createvv [options] <usr_CPG> <VV_name> [.<index>] <size>[g|G|t|T]
```

Here is an example:

```
# createvv -cnt 5 TESTLUNS 5G
```

**NOTE:** To create thinly-provisioned virtual volumes, an HP 3PAR Thin Provisioning license is required.

Consult the *HP 3PAR Management Console Help* and the *HP 3PAR Command Line Interface Reference* for complete details on creating volumes for the HP 3PAR OS version that is being used on the HP 3PAR StoreServ Storage.

These documents are available on the HP SC website:

[HP Support Center](#)

---

**NOTE:** The commands and options available for creating a virtual volume may vary for earlier versions of the HP 3PAR OS.

---

## Creating Thinly-provisioned Virtual Volumes

To create thinly-provisioned virtual volumes (TPVVs), see the following documents:

- *HP 3PAR StoreServ Storage Concepts Guide*
- *HP 3PAR Command Line Interface Administrator's Manual*
- *HP 3PAR Command Line Interface Reference*

These documents are available on the HP SC website:

[HP Support Center](#)

## Exporting LUNs to the Host

This section explains how to export LUNs to the host as VVs, referred to as virtual LUNs (VLUNs).

To export VVs as VLUNs, issue the following command:

```
createvln [-cnt] <number of LUNs> <name_of_virtual_LUNs.int> <starting_LUN_number>  
<hostname/hostdefinition>
```

where:

- `[-cnt]` specifies the number of identical VVs to create using an integer from 1 through 999. If not specified, one virtual volume is created.
- `<name_of_virtual_LUNs>` specifies name of the VV being exported as a virtual LUN.
- `<starting_LUN_number>` indicates that is the starting LUN number.
- `.int` is the integer value. For every LUN created, the `.int` suffix of the VV name gets increased by an increment of one.
- `<hostname/hostdefinition>` indicates that `hostname` is the name of the host created in “Creating the Host Definition (HP 3PAR OS 3.1.x or OS 2.3.x)” (page 11) or “Creating the Host Definition (HP 3PAR OS 2.2.x)” (page 13).

Example:

```
# createvln -cnt 5 TESTLUNS.0 0 hostname/hostdefinition
```

To verify that VLUNs have been created, issue the `showvln` command:

```
# showvln  
  
Active VLUNs  
Lun VVName      HostName      -----Host_WWN/iSCSI_Name----- Port Type  
0 TESTLUNS.0    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 0:3:1 host  
1 TESTLUNS.1    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 0:3:1 host  
2 TESTLUNS.2    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 0:3:1 host  
3 TESTLUNS.3    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 0:3:1 host  
4 TESTLUNS.4    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 0:3:1 host  
5 TESTLUNS.5    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 0:3:1 host  
6 TESTLUNS.6    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 0:3:1 host  
7 TESTLUNS.7    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 0:3:1 host  
8 TESTLUNS.8    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 0:3:1 host  
9 TESTLUNS.9    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 0:3:1 host  
0 TESTLUNS.0    sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 1:3:1 host
```



```
1 TESTLUNS.1 sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 1:3:1 host
2 TESTLUNS.2 sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 1:3:1 host
3 TESTLUNS.3 sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 1:3:1 host
4 TESTLUNS.4 sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 1:3:1 host
5 TESTLUNS.5 sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 1:3:1 host
6 TESTLUNS.6 sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 1:3:1 host
7 TESTLUNS.7 sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 1:3:1 host
8 TESTLUNS.8 sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 1:3:1 host
9 TESTLUNS.9 sqa-dl380g5-05 iqn.1994-05.com.redhat:33853dd5ab2e 1:3:1 host
-----
20 total

VLUN Templates
Lun VVName      HostName      -Host_WWN/iSCSI_Name- Port Type
0 TESTLUNS.0 sqa-dl380g5-05 ----- --- host
1 TESTLUNS.1 sqa-dl380g5-05 ----- --- host
2 TESTLUNS.2 sqa-dl380g5-05 ----- --- host
3 TESTLUNS.3 sqa-dl380g5-05 ----- --- host
4 TESTLUNS.4 sqa-dl380g5-05 ----- --- host
5 TESTLUNS.5 sqa-dl380g5-05 ----- --- host
6 TESTLUNS.6 sqa-dl380g5-05 ----- --- host
7 TESTLUNS.7 sqa-dl380g5-05 ----- --- host
8 TESTLUNS.8 sqa-dl380g5-05 ----- --- host
9 TESTLUNS.9 sqa-dl380g5-05 ----- --- host
-----
10 total
```

## Restrictions on Volume Size and Number

Follow the guidelines for creating virtual volumes (VVs) and Virtual LUNs (VLUNs) in the *HP 3PAR Command Line Interface Administrator's Manual* while adhering to these cautions and guidelines:

- This configuration supports sparse LUNs (meaning that LUNs may be skipped). LUNs may also be exported in non-ascending order (e.g. 0, 5, 7, 3).
- The HP 3PAR StoreServ Storage supports the exportation of VLUNs with LUNs in the range from 0 to 65535.
- The maximum LUN size that can be exported to an RHEL host is 16 TB when the installed HP 3PAR OS version is 2.3.x or 3.1.x. A LUN size of 16 TB on an RHEL host is dependent on the installed RHEL version and update since some older versions of RHEL will not support a volume greater than 2 TB.

## Discovering Devices with an Emulex HBA

Use one of the following methods to dynamically add new LUNs:

- Use the `echo` statement.
- Use the `echo scsi add` statement.

HP recommends that you use the `echo` statement method where the scan is performed using the `sys device tree`.

## Scan Methods for LUN Discovery

You can use the following methods to discover LUNs from the RHEL host.

- Method 1: Uses `sysfs scan` for scanning multiple devices at once
- Method 2: Uses adding `single devices` for adding single devices one at a time

## Method 1 - sysfs Scan

After exporting VLUNs to the host using the `createvln` command in [“Exporting LUNs to the Host” \(page 104\)](#), use the `echo` statement on the `sysfs` file system to scan for devices. Use the `cat/proc/scsi/scsi` command, or other useful commands such as `lsscsi -g` or `sginfo -l` option, to get a list of device path information:

```
# echo "- <target number> <lun number>" > <device scan path>
```

Example:

The device path is `/sys/class/scsi_host/host2` and the target is 0 (target2:0:0) and the exported device is LUN 1. The following is the `echo` command to be used.

```
# echo "- 0 1" > /sys/class/scsi_host/host2/scan
```

The following message log provides an example of the resulting output:

```
kernel: Vendor: 3PARdata Model: VV Rev: 0000
kernel: Type: Direct-Access ANSI SCSI revision: 03
kernel: SCSI device sdv: 524288 512-byte hdwr sectors (268 MB)
kernel: SCSI device sdv: drive cache: write back
kernel: sdv: unknown partition table
kernel: Attached scsi disk sdv at scsi2, channel 0, id 0, lun 1
kernel: Attached scsi generic sg22 at scsi2, channel 0, id 0, lun 1, type 0
scsi.agent[12915]: disk at /devices/pci0000:00/0000:00:02.0/0000:01:00.2/
0000:03:0b.0/0000:04:04.0/host2/target2:0:0/2:0:0:1
```

Alternatively, you can scan for all LUNs and targets for a given `lpfc` instance using the following command:

```
# echo "- - -" > /sys/class/scsi_host/host2/scan
```

OR use the following script to scan for all LUNs for all the `lpfc` instances:

```
# /usr/bin/rescan-scsi-bus.sh -r --nooptscan
```

If the device has changed its size, then issue the following command to obtain the new disk size:

```
# echo 1 > /sys/class/scsi_device/2:0:0:1/device/rescan
```

The rescan must be performed on all device paths to the host. To see the change in size, issue the following command for Device-mapper multipath:

```
# multipathd -k
multipathd> resize map 350002ac000350102
ok
multipathd> exit
```

## Method 2 - Adding Single Devices

To add LUNs by using the `echo scsi add` statement, run the following commands:

```
# echo "scsi add-single-device 0 1 2 3" > /proc/scsi/scsi
```

where:

- 0 specifies the host
- 1 specifies the channel
- 2 specifies the ID
- 3 specifies the LUN

(The SCSI midlayer will re-scan.)

```
# echo "scsi add-single-device 2 0 0 14" > /proc/scsi/scsi
```

You can see the new LUN presented to the OS by the SCSI Mid-Layer in the `/var/log/messages` file.

```
kernel: Vendor: 3PARdata Model: VV Rev: 0000
kernel: Type: Direct-Access ANSI SCSI revision: 03
kernel: SCSI device sdac: 524288 512-byte hdwr sectors (268 MB)
kernel: SCSI device sdac: drive cache: write back
kernel: sdac: unknown partition table
kernel: Attached scsi disk sdac at scsi2, channel 0, id 0, lun 14
kernel: Attached scsi generic sg29 at scsi2, channel 0, id 0, lun 14, type 0
Dec 12 14:08:50 sqa-dell2850-01 scsi.agent[14234]: disk at /devices/pci0000:00/
0000:00:02.0/0000:01:00.2/0000:03:0b.0/0000:04:04.0/host2/target2:0:0/2:0:0:14
```

**NOTE:** The echo command needs to be executed on multiple host `lpfc` HBA SCSI instances where LUNs have been exported.

## Verifying Devices Found by the Host Using the Emulex HBA

To verify that the RHEL host has discovered the exported devices, look at the contents of the `/proc/scsi/scsi` file. In this example, we have LUN 0 exported to the RHEL host through eight paths (four HP 3PAR StoreServ Storage ports connecting to two Emulex HBA ports). This file should contain entries for the attached devices:

HP 3PAR StoreServ Storage

```
# cat /proc/scsi/scsi
[root@sqa-dl380g5-05 ~]# cat /proc/scsi/scsi
Attached devices:
Host: scsi4 Channel: 00 Id: 00 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 3110
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi5 Channel: 00 Id: 00 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 3110
  Type:   Direct-Access                          ANSI SCSI revision: 05
```

`scsi4` and `scsi5` refer to the HBA adapter instances (`/sys/class/scsi_host/host4` and `/sys/class/scsi_host/host5`), respectively. Alternatively, use `Isscsi -g` for RedHat 5 or 6.

## Discovering Devices with a QLogic HBA

Use one of the following methods to dynamically add new LUNs:

The method of `echo` statement following the QLogic scan `scsi-qlascan` and the method of `echo scsi add` statement. .

- Use the `scsi-qlascan` command.
- Use the `echo` statement following the QLogic scan `scsi-qlascan`
- Use the `echo scsi add` statement

HP recommends that you use the `echo` statement method where the scan is performed using the `sys device tree`

## Scan Methods for LUN Discovery

Use one of the following methods to discover LUNs from the RHEL host:

- Method 1: Uses `sysfs` scan through the `echo` statement for adding multiple devices at once
- Method 2: Uses `add single device` for adding a single device at a time

### Method 1 - `sysfs` Scan Using the `echo` Statement

After exporting VLUNs to the host using the `createvln` command in [“Exporting LUNs to the Host” \(page 104\)](#), use the QLogic scan `scsi-qlascan` command to discover devices by completing the following steps:

**NOTE:** If you are using the QLogic driver that is installed during the OS installation, you can skip performing the `scsi -qlascan` script and scan for devices using the following `echo` command:

```
# echo " - <target number> <LUN number>" > <device scan path>
```

1. Run the `scsi-qlascan` script by issuing the following command:

```
# echo "scsi-qlascan" > /proc/scsi/qla2xxx/<adapter-id>
```

**NOTE:** The `scsi-qlascan` command works only if the QLogic driver was installed from the QLogic website. A limited number of QLogic drivers are available on the QLogic website for older versions of Linux.

In the following example, 0 is the HBA instance created by `qla2xxx` driver module:

```
# echo "scsi-qlascan" > /proc/scsi/qla2xxx/0
```

2. Repeat for any other HBA instances created by the driver module. The QLogic scan will allow the driver layer to discover the HP 3PAR StoreServ Storage.

**NOTE:** The `qla2xxx` directory instance is created only if the QLogic driver was installed from the QLogic website for older versions of Linux.

Example:

```
# cat /proc/scsi/qla2xxx/0
QLogic PCI to Fibre Channel Host Adapter for QLA2462:
    Firmware version 4.06.03 [IP] [84XX] , Driver version 8.02.23
BIOS version 1.29
FCODE version 1.27
EFI version 1.09
```

```
Flash FW version 4.00.30 0082
ISP: ISP2422, Serial# RFC0823R29292
Request Queue = 0x12a10000, Response Queue = 0x12a690000
Request Queue count = 4096, Response Queue count = 512
Total number of active commands = 0
Total number of interrupts = 12368
    Device queue depth = 0x20
Number of free request entries = 282
Number of mailbox timeouts = 0
Number of ISP aborts = 0
Number of loop resyncs = 0
Number of retries for empty slots = 0
Number of reqs in pending_q= 0, retry_q= 0, done_q= 0, scsi_retry_q= 0
Host adapter:loop state = <READY>, flags = 0x5a43
Dpc flags = 0x0
MBX flags = 0x0
Link down Timeout = 030
Port down retry = 001
Login retry count = 008
Commands retried with dropped frame(s) = 0
Product ID = 0000 0000 0000 0000
```

#### SCSI Device Information:

```
scsi-qla0-adapter-node=2000001b321a0c63;
scsi-qla0-adapter-port=2100001b321a0c63;
scsi-qla0-target-0=20410002ac000031;
scsi-qla0-target-1=20510002ac000031;
scsi-qla0-target-2=21410002ac000031;
scsi-qla0-target-4=21510002ac000031;
```

#### FC Port Information:

```
scsi-qla0-port-0=2ff70002ac000031:20410002ac000031:090800:81;
scsi-qla0-port-1=2ff70002ac000031:20510002ac000031:050100:82;
scsi-qla0-port-2=2ff70002ac000031:21410002ac000031:030000:83;
scsi-qla0-port-4=2ff70002ac000031:21510002ac000031:6b0600:84;
```

#### SCSI LUN Information:

(Id:Lun) \* - indicates lun is not registered with the OS.

```
( 0: 0): Total reqs 156, Pending reqs 0, flags 0x0, Dflags 0x0, 0:0:81 00
( 1: 0): Total reqs 158, Pending reqs 0, flags 0x0, Dflags 0x0, 0:0:82 00
( 2: 0): Total reqs 174, Pending reqs 0, flags 0x0, Dflags 0x0, 0:0:83 00
( 4: 0): Total reqs 140, Pending reqs 0, flags 0x0, Dflags 0x0, 0:0:84 00
```

3. Once the driver layer has discovered the device, run the `echo` statement for the RHEL OS layer to discover the HP 3PAR devices. This command should also be used for a QLogic driver installed as part of the OS install to initiate LUN discovery from both the driver and SCSI layer together:

```
# echo " - <target number> <lun number>" > <device scan path>
```

If the device path is `/sys/class/scsi_host/host2`, the target is 0 (target 2:0:0), and the exported device is LUN 1, then the `echo` statement would appear as the following example:

```
# echo "- 0 1" > /sys/class/scsi_host/host2/scan
```

The following message log provides an example of the resulting output:

```
kernel: Vendor: 3PARdata Model: VV Rev: 0000
kernel: Type: Direct-Access ANSI SCSI revision: 03
kernel: SCSI device sdv: 524288 512-byte hdwr sectors (268 MB)
kernel: SCSI device sdv: drive cache: write back
kernel: sdv: unknown partition table
kernel: Attached scsi disk sdv at scsi2, channel 0, id 0, lun 1
kernel: Attached scsi generic sg22 at scsi2, channel 0, id 0, lun 1, type 0
scsi.agent[12915]: disk at /devices/pci0000:00/0000:00:02.0/0000:01:00.2/
0000:03:0b.0/0000:04:04.0/host2/target2:0:0/2:0:0:1
```

- Alternatively, you can scan for all LUNs and targets for a given `qla2xxx` instance using the following command:

```
# echo "- - -" > /sys/class/scsi_host/host2/scan
```

- If the device has changed its size, then issue the following command to obtain the new disk size:

```
# echo 1 > /sys/class/scsi_device/2:0:0:1/device/rescan
```

Alternatively, you can use the `rescan-scsi-bus.sh` script, with the `-r -nooptscan` options, to scan and discover LUNs.

## Method 2 - Scan using add single device

This method involves performing a QLogic driver scan `scsi-qlascan` followed by adding LUNs using the `echo scsi add` statement. To scan using add single device method, complete the following steps.

**NOTE:** If you are using the QLogic driver that is installed during the OS installation, you can skip performing the `scsi -qlascan` script and scan for devices using the following `echo` command:

```
# echo " - <target number> <LUN number>" > <device scan path>
```

1. Issue `scsi-glascan` to discover devices:

```
# echo "scsi-glascan" > /proc/scsi/qla2xxx/<adapter-id>
```

2. Once the new LUN is visible to the QLogic driver layer, force the SCSI mid-layer to do its own scan and build the device table entry for the new device:

```
# echo "scsi add-single-device 0 1 2 3" >/proc/scsi/scsi
```

The SCSI midlayer will re-scan, where 0 1 2 3 is replaced by your host, channel, ID, and LUN.

Example:

```
# echo "scsi add-single-device 4 0 0 1" > /proc/scsi/scsi
```

**NOTE:** You must run the `scsi add-single-device` command individually for all the newly discovered LUNs and on all host ports to which the LUNs were exported.

You can see the new LUN presented to the OS by the SCSI mid-Layer in the `/var/log/messages` file.

```
kernel: qla2300 0000:03:08.0: scsi(4:0:0:1): Enabled tagged queuing, queue
depth 32.
kernel: SCSI device sdh: 14680064 512-byte hdwr sectors (7516 MB)
kernel: SCSI device sdh: drive cache: write back
kernel: sdh: sdh1
kernel: Attached scsi disk sdh at scsi4, channel 0, id 0, lun 1
kernel: Attached scsi generic sg8 at scsi4, channel 0, id 0, lun 2, type
0scsi.agent[1203]: disk at /devices/pci0000:03/0000:03:08.0/host4/target4:0:0/
4:0
```

## Verifying Devices Found by the Host Using the QLogic HBA

**NOTE:** If you are running RHEL 4.x with QLogic In-Box driver after presenting new LUNs, the following commands need to be executed on the host system to see the new LUNs. For example:

```
# echo "1" > /sys/class/fc_host/host0/issue_lip
# echo "1" > /sys/class/fc_host/host1/issue_lip
# echo "- - -" > /sys/class/scsi_host/host0/scan
# echo "- - -" > /sys/class/scsi_host/host1/scan
```

In the above example, `host0` and `host1` are adapter instances.

To verify that the RHEL host has discovered the exported devices, look at the contents of the file `/proc/scsi/scsi`. In this example, LUN 0 is exported to the RHEL host through eight paths (four HP 3PAR StoreServ Storage ports connecting to two QLogic HBA ports). This file should contain entries for the attached devices:

---

**NOTE:** The example shows other LUNs besides the eight instances of LUN 0.

---

```
# cat /proc/scsi/scsi
Attached devices:
Host: scsi0 Channel: 00 Id: 00 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi0 Channel: 00 Id: 01 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi0 Channel: 00 Id: 02 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi0 Channel: 00 Id: 04 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi0 Channel: 00 Id: 04 Lun: 01
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi0 Channel: 00 Id: 04 Lun: 02
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi0 Channel: 00 Id: 04 Lun: 03
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi0 Channel: 00 Id: 04 Lun: 04
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi1 Channel: 00 Id: 00 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi1 Channel: 00 Id: 01 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi1 Channel: 00 Id: 02 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
Host: scsi1 Channel: 00 Id: 04 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
```

`scsi0` and `scsi1` refer to the HBA adapter instances (`/proc/scsi/qla2xxx/0` and `/proc/scsi/qla2xxx/1`), respectively. The `Id` refers to the HP 3PAR StoreServ Storage target port (there are four HP 3PAR StoreServ Storage target ports: `Id 0`, `1`, `2`, `4`).

## Discovering Devices with a Software iSCSI Connection

The methods for discovering LUNs with an iSCSI connection differ between RHEL 4 on the one hand and RHEL 6 or RHEL 5 on the other.

For information about discovering devices with a hardware iSCSI connection, see [“Setting Up Hardware iSCSI for RHEL 6 or RHEL 5”](#) (page 60).

## Discovering Devices with RHEL 6 or RHEL 5

Complete the following steps to discover devices with an iSCSI connection on the RHEL 6 or RHEL 5 host:

---

**NOTE:** When VLUNs are exported, they will not appear on the host automatically. After a new VLUN is exported from an HP 3PAR StoreServ Storage iSCSI port, rescan for new LUNs.

---

1. Scan for new LUNs using the `iscsiadm -m node -R` or `iscsiadm -m session -R`.



2. Verify that the iSCSI exported volumes have been discovered.

```
# cat /proc/scsi/scsi
Attached devices:
Host: scsi1 Channel: 00 Id: 00 Lun: 00
  Vendor: 3PARdata Model: VV                      Rev: 0000
  Type:   Direct-Access                          ANSI SCSI revision: 05
```

3. To verify device-mapper-multipath, run the `multipath -ll` command.

```
# multipath -ll
350002ac00021014b dm-3 3PARdata,VV
[size=20G][features=1 queue_if_no_path][hwhandler=0][rw]
\_ round-robin 0 [prio=2][active]
  \_ 8:0:0:3   sdc   8:32   [active][ready]
  \_ 9:0:0:3   sdd   8:48   [active][ready]
350002ac00027014b dm-9 3PARdata,VV
[size=5.0G][features=1 queue_if_no_path][hwhandler=0][rw]
\_ round-robin 0 [prio=2][active]
  \_ 8:0:0:12  sdo   8:224  [active][ready]
  \_ 9:0:0:12  sdq   8:240  [active][ready]
350002ac00022014b dm-4 3PARdata,VV
[size=20G][features=1 queue_if_no_path][hwhandler=0][rw]
\_ round-robin 0 [prio=2][active]
  \_ 8:0:0:4   sde   8:64   [active][ready]
  \_ 9:0:0:4   sdf   8:80   [active][ready]
350002ac00028014b dm-11 3PARdata,VV
[size=5.0G][features=1 queue_if_no_path][hwhandler=0][rw]
\_ round-robin 0 [prio=2][active]
  \_ 8:0:0:13  sdq   65:0   [active][ready]
  \_ 9:0:0:13  sdr   65:16  [active][ready]
```

## Discovering Devices with RHEL 4

Complete the following steps to discover devices with an iSCSI connection on the RHEL 4 Host:

1. On the RHEL 4 iSCSI Initiator host, use the `iscsi-rescan` command to rescan for the newly exported LUN:

```
# iscsi-rescan
Rescanning host10
Rescanning host11
```

2. Use the `iscsi -ls` command to display the scanned iSCSI devices.
3. Verify the contents of `/proc/scsi/scsi` for the new device:

```
# cat /proc/scsi/scsi
Attached devices:
Host: scsi2 Channel: 00 Id: 00 Lun: 00
Vendor: 3PARdata Model: VV Rev: 0000
Type: Direct-Access ANSI SCSI revision: 05
```

4. Check the block device files created in the system:

```
# ls /sys/block/sd*  
/sys/block/sda:  
dev device queue range removable sda1 size stat
```

5. Verify which block device files are HP 3PAR volumes:

```
# cat /sys/block/sd*/device/vendor  
ATA  
ATA  
3PARdata
```

6. You can verify an iSCSI device with the following command:

```
# iscsi-device /dev/sdc  
/dev/sdc is an iSCSI device
```



**WARNING!** The current RHEL 4 Update 5 iSCSI implementation does *not* properly handle the mounting of file systems on iSCSI devices bootup time and does NOT properly handle the unmounting of file systems on iSCSI devices while shutting down and/or rebooting the host. A workaround is to have scripts to mount the file systems after the host has booted and the proper devices have been created and have scripts to unmount them before shutting down or rebooting the host.

## 9 Modifying HP 3PAR Devices on the Host

### Creating Device-mapper Devices

Complete the following steps to create Device-mapper devices.

1. Run the `multipath` command to create new Device-mapper nodes under the `/dev/mapper` directory.

```
# multipath
```

2. Verify that the Device-mapper devices have been created by issuing `multipath -ll`.  
For example, in the following RHEL 4 host output, the `/dev/mapper/350002ac0000c003e` Device-mapper node is seen from device `sda` on driver instance (0:0:0:0) and from `sdb` on driver instance (1:0:0:0).

**NOTE:** RHEL 5.5 and later, including RHEL 6.x, have the `user_friendly_names` option for dm multipathing turned on by default. This means that instead of device names like `350002ac001b40031` they will appear as `mpathX`, giving paths of `/dev/mapper/mpathX` in `kpartx` and other tools as per the RHEL documentation.

```
# multipath -ll
350002ac001b40031
[size=5 GB][features="1 queue_if_no_path"][hwhandler="0"]
\_ round-robin 0 [active]
\_ 0:0:0:0 sda 8:0 [active][ready]
\_ 1:0:0:0 sdb 8:16 [active][ready]
```

3. After creating the devices, use the `multipath -v 3` command to retrieve more detailed information about Device-mapper nodes and their associated paths. Make sure of the following settings:
  - The path checker is set to `tur` for each of the devices.
  - The `no_path_retry` is set to a value of 12 for iSCSI and 18 for Fibre Channel if the HP 3PAR array is running HP 3PAR OS 3.1.1 or later. However, if the HP 3PAR array is running an HP 3PAR OS version earlier than 3.1.1, then the `no_path_retry` is set to 12 for iSCSI and 12 for Fibre Channel.

Output from the `multipath -v 3` command differs in RHEL 4 on the one hand and RHEL 6 or RHEL 5 on the other; however, the information displayed on the Device-mapper remains the same.

Example using RHEL 5:

```
# multipath -v 3
sdc: not found in pathvec
sdc: mask = 0x1f
sdc: bus = 1
sdc: dev_t = 8:32
sdc: size = 10485760
sdc: vendor = 3PARdata
sdc: product = VV
sdc: rev = 0000
sdc: h:b:t:l = 2:0:0:0
sdc: serial = 004B0079
sdc: path checker = tur (controller setting)
sdc: state = 2
```

```

sdc: getprio = /bin/true (config file default)
sdc: prio = 0
sdc: getuid = /sbin/scsi_id -g -u -s /block/%n (config file default)
sdc: uid = 350002ac0004b0079 (callout)
sdd: not found in pathvec
sdd: mask = 0x1f
sdd: bus = 1
sdd: dev_t = 8:48
sdd: size = 10485760
sdd: vendor = 3PARdata
sdd: product = VV
sdd: rev = 0000
sdd: h:b:t:l = 3:0:0:0
sdd: serial = 004B0079
sdd: path checker = tur (controller setting)
sdd: state = 2
sdd: getprio = /bin/true (config file default)
sdd: prio = 0
sdd: getuid = /sbin/scsi_id -g -u -s /block/%n (config file default)
sdd: uid = 350002ac0004b0079 (callout)
===== paths list =====
uuid                                hcil      dev dev_t pri dm_st  chk_st  vend/prod/r
350002ac0004b0079                  2:0:0:0 sdc 8:32   0   [undef] [ready] 3PARdata,VV
350002ac0004b0079                  3:0:0:0 sdd 8:48   0   [undef] [ready] 3PARdata,VV
params = 1 queue_if_no_path 0 1 1 round-robin 0 2 1 8:32 100 8:48 100
status = 2 0 0 0 1 1 E 0 2 0 8:32 A 0 8:48 A 0
sdc: mask = 0x8
sdc: prio = 0
sdd: mask = 0x8
sdd: prio = 0
sdc: ownership set to 350002ac0004b0079
sdc: not found in pathvec
sdc: mask = 0xc
sdc: state = 2
sdc: prio = 0
sdd: ownership set to 350002ac0004b0079
sdd: not found in pathvec
sdd: mask = 0xc
sdd: state = 2
sdd: prio = 0
350002ac0004b0079: pgfailback = -2 (config file default)
350002ac0004b0079: pgpolicy = multibus (controller setting)
350002ac0004b0079: selector = round-robin 0 (internal default)
350002ac0004b0079: features = 0 (internal default)
350002ac0004b0079: hwhandler = 0 (internal default)
350002ac0004b0079: rr_weight = 2 (config file default)
350002ac0004b0079: minio = 100 (config file default)
350002ac0004b0079: no_path_retry = 60 (controller setting)
pg_timeout = NONE (internal default)
350002ac0004b0079: set ACT_NOTHING (map unchanged)

```

#### Example using RHEL 4:

```

# multipath -v 3
load path identifiers cache
#
# all paths in cache :
#
350002ac001b40031 0:0:0:0 sda 8:0   [active] 3PARdata/VV          /0000
350002ac001b40031 1:0:0:0 sdb 8:16   [active] 3PARdata/VV          /0000
===== path info sda (mask 0x1f) =====
bus = 1
dev_t = 8:0
size = 10485760

```

```

vendor = 3PARdata
product = VV
rev = 0000
h:b:t:l = 0:0:0:0
tgt_node_name =
serial = 01B40031
path checker = tur (controler setting)
state = 2
getprio = /bin/true (internal default)
prio = 0
uid = 350002ac001b40031 (cache)
===== path info sdb (mask 0x1f) =====
bus = 1
dev_t = 8:16
size = 10485760
vendor = 3PARdata
product = VV
rev = 0000
h:b:t:l = 1:0:0:0
tgt_node_name =
serial = 01B40031
path checker = tur (controler setting)
state = 2
getprio = /bin/true (internal default)
prio = 0
uid = 350002ac001b40031 (cache)
#
# all paths :
#
350002ac001b40031 0:0:0:0 sda 8:0 [active][ready] 3PARdata/VV /
350002ac001b40031 1:0:0:0 sdb 8:16 [active][ready] 3PARdata/VV
params = 1 queue_if_no_path 0 1 1 round-robin 0 2 1 8:0 100 8:16 100
status = 2 0 0 0 1 1 A 0 2 0 8:0 A 0 8:16 A 0
===== path info sda (mask 0x8) =====
prio = 0
uid = 350002ac001b40031 (cache)
===== path info sdb (mask 0x8) =====
prio = 0
uid = 350002ac001b40031 (cache)
pgpolicy = multibus (controler setting)
selector = round-robin 0 (internal default)
features = 0 (internal default)
hwhandler = 0 (internal default)
rr_weight = 2 (config file default)
rr_min_io = 100 (config file default)
no_path_retry = 12 (controler setting)
pg_timeout = NONE (internal default)
0 10485760 multipath 0 0 1 1 round-robin 0 2 1 8:0 100 8:16 100
set ACT_NOTHING: map unchanged

```

## Displaying Detailed Device-mapper Node Information

Use the `multipath -l` to list devices and the `dmsetup` command to get detailed Device-mapper node information.

**NOTE:** With `no_path_retry` set to a value other than 0 in the `/etc/multipath.conf` file, I/O will be queued for the period of the retries and `features=1 queue_if_no_path` will be shown in `multipath -l` command output.

Example:

**NOTE:** If you see the device status as [undef] in the output, this is an RHEL defect that has been raised with RHEL to be fixed. Instead, use the `multipath -ll` command, which shows the correct device status as ready.

The `dmsetup` command can be used with various options to get more information on Device-mapper mappings.

Example:

```
# dmsetup table
350002ac001b40031: 0 10485760 multipath 1 queue_if_no_path 0 1 1 round-robin 0 2 1
8:0 100 8:16 100

# dmsetup ls --target multipath
350002ac0004b0079          (253, 7)

# dmsetup info 350002ac0004b0079
Name:           350002ac0004b0079
State:          ACTIVE
Read Ahead:     256
Tables present: LIVE
Open count:     1
Event number:   0
Major, minor:   253, 7
Number of targets: 1
UUID: mpath-350002ac0004b0079

# dmsetup table --target multipath
350002ac0004b0079: 0 10485760 multipath 1 queue_if_no_path 0 1 1 round-robin 0 2 1
8:32 100 8:48 100
```

## Partitioning Device-mapper Nodes

The following section provides guidelines for partitioning Device-mapper nodes.

When partitioning a Device-mapper node, do *not* use `fdisk` on the `/dev/mapper/XXX` nodes. The following error output may be seen as a result of using `fdisk`.



**WARNING!** Rereading the partition table failed with error 22: Invalid argument. The kernel still uses the old table. The new table will be used at the next reboot. Syncing disks

**NOTE:** Do *not* use the `fdisk` command with `/dev/mapper/XXX` devices to create partitions.

Use `fdisk` on the underlying disks `/dev/sdXX` and execute the following command when Device-mapper multipath maps the device to create a `/dev/mapper/<device node>` partition.

```
# multipath -l
50002ac001b40031
[size=5 GB] [features="1 queue_if_no_path"] [hwhandler="0"]
\_ round-robin 0 [active]
  \_ 0:0:0:0 sda 8:0 [active]
  \_ 1:0:0:0 sdb 8:16 [active]
```

Device-mapper node 350002ac001b40031 is formed from underlying devices `sda` and `sdb` representing two paths from the same storage volume.

```
# fdisk /dev/sda -- create a partition
```

After the `fdisk` command completes, use the `kpartx` command to list and create DM devices for the partitions on the device:

```
# kpartx -a -p p /dev/mapper/350002ac001b40031
350002ac001b40031p1 : 0 10477194 /dev/mapper/350002ac001b40031 62
# kpartx -a -p p /dev/mapper/350002ac001b40031 -- will add a partition mapping
# ls /dev/mapper
350002ac001b40031 350002ac001b40031p1
```

where `350002ac001b40031p1` is a partition device of whole disk `350002ac001b40031`.

## fdisk or Parted Usage on RHEL 6.x for Disk Alignment

HP 3PAR StoreServ Storage cache pages are 16 KB (16384 bytes), which means read and write operations are performed in terms of 16 k cache pages. In accordance with the JEDEC memory standards, HP 3PAR OS 3.1.1 or later supports block limits pages (bl), which tell the host the optimal transfer blocks that are supported, and which the OS can use for the creation of partitioning to align with the cache page for performance improvements. RHEL 6 with HP 3PAR OS 3.1.1 or later uses these bits with specific `fdisk` and `parted` options.

Example: On RHEL 6.x, if you have installed the `sg3_utils`, the following command displays the block limits VPD page (SBC). The optimal transfer length granularity is 32 blocks (16 k).

```
# sg_vpd -p bl /dev/sdh
Block limits VPD page (SBC):
Optimal transfer length granularity: 32 blocks
Maximum transfer length: 32768 blocks
Optimal transfer length: 32768 blocks
Maximum prefetch, xread, xwrite transfer length: 0 blocks
Maximum unmap LBA count: 65536
Maximum unmap block descriptor count: 10
Optimal unmap granularity: 32
Unmap granularity alignment valid: 0
Unmap granularity alignment: 0
```

If you are running RHEL 6.x with HP 3PAR OS 3.1.1 or later, you can take advantage of the SBC bits in the `fdisk` command to properly align the starting sector of the partition with the cache page alignment (16 k) by passing the `-c` flag (switch off DOS-compatible mode) to the `fdisk` command along with the `-u` option, which shows the output in sectors.

```
# fdisk -c -u /dev/sdh
Command (m for help): p
Partition number (1-4): 1
First sector (32768-10485759, default 32768):
Using default value 32768
```

The foregoing command shows that the partition start sector begins at sector 32768 (with a proper 16 k offset), which is properly aligned.

```
# fdisk -l -u /dev/sdh
Disk /dev/sdh: 5368 MB, 5368709120 bytes
52 heads, 10 sectors/track, 20164 cylinders, total 10485760 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 16384 bytes / 16777216 bytes
Disk identifier: 0x0004b8d4
```

Device	Boot	Start	End	Blocks	Id	System
/dev/sdh1		32768	10485759	5226496	83	Linux

If the `-c` or `-u` flag is not used during the creation of the partition, then the start sector is 30876, and a warning "Partition 1 does not start on physical sector boundary" appears after the partition is created.

Example without the `-c` flag or `-u` flag:

```
# fdisk /dev/sdh
WARNING: DOS-compatible mode is deprecated. It's strongly recommended to
switch off the mode (command 'c') and change display units to
sectors (command 'u').

Command (m for help): n
Command action
   e   extended
   p   primary partition (1-4)
p
Partition number (1-4): 1
First cylinder (1-1018, default 4):
Using default value 4
Last cylinder, +cylinders or +size{K,M,G} (4-1018, default 1018):
Using default value 1018

# fdisk -l -u /dev/sdh

Disk /dev/sdh: 5368 MB, 5368709120 bytes
166 heads, 62 sectors/track, 1018 cylinders, total 10485760 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 16384 bytes / 16777216 bytes
Disk identifier: 0x2d8b4dbe

   Device Boot      Start         End      Blocks   Id  System
/dev/sdh1          30876       10477255      5223190    83   Linux

Partition 1 does not start on physical sector boundary.
```

Also, if the alignment is not proper, the following warning about poor performance during the creation of ext filesystems appears.

```
# mkfs.ext4 /dev/mapper/350002ac000020121p1
mke2fs 1.41.12 (17-May-2010)
/dev/mapper/350002ac000020121p1 alignment is offset by 2048 bytes.
This may result in very poor performance, (re)-partitioning suggested.
```

The same result can be achieved using the parted command, with the units in GB so that proper alignment occurs on HP 3PAR OS 3.1.1 or later. The following example shows alignment starting at sector 32768:

```
# parted /dev/sdh
GNU Parted 2.1
Using /dev/sdh
Welcome to GNU Parted! Type 'help' to view a list of commands.
(parted) mklabel
New disk label type? msdos
(parted) unit gb
(parted) mkpart primary
```



```
File system type? [ext2]? ext4
Start? 0
End? -0
(parted) p
Model: 3PARdata VV (scsi)
Disk /dev/sdh: 5.37GB
Sector size (logical/physical): 512B/512B
Partition Table: msdos

Number  Start      End          Size         Type        File system  Flags
  1       0.02GB    5.37GB      5.35GB      primary     ext4

(parted) unit s
(parted) p
Model: 3PARdata VV (scsi)
Disk /dev/sdh: 10485760s
Sector size (logical/physical): 512B/512B
Partition Table: msdos

Number  Start      End          Size         Type        File system  Flags
  1     32768s 10485759s 10452992s  primary     ext4

(parted) unit mb
(parted) print
Model: 3PARdata VV (scsi)
Disk /dev/sdh: 5369MB
Sector size (logical/physical): 512B/512B
Partition Table: msdos

Number  Start      End          Size         Type        File system  Flags
  1     16.8MB 5369MB      5352MB      primary     ext4
```

If you are running HP 3PAR OS 2.3.1 with RHEL 6.x, then for proper alignment, make sure to pass sector 32768 as the start sector with the `fdisk -c -u` option, or use the appropriate unit to start with (such as 16.8 MB) in a parted command.



**WARNING!** While using `fdisk`, make sure the correct underlying device is used. Use the `multipath` command to identify the underlying device.

**WARNING!** All I/O creating the file system and mount points needs to be done using the Device-mapper device nodes `/dev/mapper/XXX`.

Data corruption will occur if any I/O is attempted on `/dev/sdX` device nodes.

**WARNING!** Issuing the `multipath -F` command will flush out all the Device-mapper mapping and can be very destructive if I/O is being served to any of the existing devices. Avoid using the `-F` option.

Use `kpartx` to delete a Device-mapper instance and then use `fdisk` to delete the partition.

The Device-mapper node name represents the storage volume ID (excluding the first digit 3). Use the HP 3PAR OS CLI `showvv` or `showvln` commands to get the volume name it represents.

Example:

1. On your FC connected host run `ls /dev/mapper`.

```
# ls /dev/mapper
350002ac001b40031
```

2. Run the `showvln` command on the HP 3PAR StoreServ Storage using the output above (minus first digit).

```
# showvln -lvw -a |grep -i 50002ac001b40031
0 testvln 50002AC001B40031 redhathost 2100001B321A0C63      0:4:1 host
0 testvln 50002AC001B40031 redhathost 2101001B323A0C63      1:5:1 host
```

3. On the iSCSI host, run `ls /dev/mapper`.

```
# ls /dev/mapper
350002AC0004B0079
```

4. On the iSCSI host, run `showvln -lvw -a |grep -i <LUN>`.

```
# showvln -lvw -a |grep -i 50002ac0004b0079
0 testvln 50002AC0004B0079 redhathost   ign.1994-05.com.redhat:a3df53b0a32d 1:3:1 host
0 testvln 50002AC0004B0079 redhathost   ign.1994-05.com.redhat:a3df53b0a32d 0:3:1 host
```

## Creating Veritas Volume Manager Devices

If the Veritas Volume Manager is being used for multipathing, and new VLUNs are exported from the storage server, complete the following steps to add new VLUNs without disrupting the I/O on the existing VLUNs:

1. Add the new exported VLUN using any of the Discovery methods.
2. After verifying that the new VLUN is detected and the device instance is created, force the Veritas layer to scan for new devices.

```
# vxdctl enable
```

3. Check that the new devices are seen by the Veritas Volume Manager. After device initialization, the status will change from being in an error state to being online.

```
# vxdisk list
DEVICE      TYPE          DISK  GROUP  STATUS
3PARDATA1_0 auto:cdsdisk   testdg testdg online
3PARDATA1_1 auto          -      -      error
```

The VLUNs discovered on the Linux host should be labeled using the Linux `fdisk` command before they can be used by the Veritas Volume Manager.

If disks are admitted to the Volume Manager, never use the raw device paths `/dev/sdX` for performing I/O, and instead use Veritas volume device paths `/dev/vx/`.

## Removing a Storage Volume from the Host

Use one of the two following methods to remove a storage volume from the host if using Device-mapper.

- Method 1

Issue the following commands:

```
# kpartx -d /dev/mapper/<device node>
# dmsetup remove <device node>
# echo "1" > /sys/class/scsi_device/<device instance>device/delete
```

For example, to remove target 0, LUN 2:

```
# kpartx -d /dev/mapper/350002ac001b40031
# dmsetup remove 350002ac001b40031
# echo "1" > /sys/class/scsi_device/0:0:0:2/device/delete
```

**NOTE:** When using the echo command, make sure the devices are removed from each of the host HBA instances.

- Method 2

Issue the following commands:

```
# kpartx -d /dev/mapper/<device node>
# dmsetup remove <device node>
echo "scsi remove-single-device <h> <c> <t> <l>" > /proc/scsi/scsi
```

where <h> is the HBA number, <c> is the channel on the HBA, <t> is the SCSI target ID, and <l> is the LUN.

Example: Remove LUN 2

```
# multipath -ll
350002ac000160121 dm-3 3PARdata,VV
size=5.0G features='1 queue_if_no_path' hwhandler='0' wp=rw
`-+- policy='round-robin 0' prio=1 status=active
   |- 0:0:0:2 sdb 8:16 active ready running
   |- 0:0:1:2 sdk 8:160 active ready running
   |- 1:0:0:2 sdt 65:48 active ready running
   `-- 1:0:1:2 sdac 65:192 active ready running

# kpartx -d /dev/mapper/350002ac000160121

# dmsetup remove 350002ac000160121

# echo "scsi remove-single-device 0 0 0 2" > /proc/scsi/scsi
# echo "scsi remove-single-device 0 0 1 2" > /proc/scsi/scsi
# echo "scsi remove-single-device 1 0 0 2" > /proc/scsi/scsi
# echo "scsi remove-single-device 1 0 1 2" > /proc/scsi/scsi
```

**NOTE:** When using the echo command, make sure the devices are removed from each of the host HBA instances.

After removing the storage volume from the host using one of the two methods, remove the VLUN from the HP 3PAR StoreServ Storage by issuing `removevlun <VVname> <LUN> <host>`.

```
# removevlun testvlun 0 redhathost
```



**WARNING!** While removing the device, make sure the correct underlying device is used. Use the `multipath` command to identify the underlying device.



**CAUTION:** For iSCSI devices, do not remove the last iSCSI device in `/proc/scsi/scsi` without first stopping multipathing, and then stopping the iSCSI daemon (`/etc/init.d/iscsi stop`). Otherwise, data corruption can occur and the host will hang.

Any change to the `/etc/multipath` configuration file requires running the `multipathd` command to be effective. If the change is not reflected, try stopping and starting the `multipathd` script.

```
# /etc/init.d/multipathd stop
# /etc/init.d/multipathd start
```

**NOTE:** The removed SCSI device is updated in `/proc/scsi/scsi`, `/proc/partitions`, and `/sys/device` path.

## UNMAP Storage Hardware Primitive Support for RHEL 6.x

HP 3PAR OS 3.1.1 or later supports the UNMAP storage primitive (operation code 42h) which is supported by RHEL 6.x OS with the `ext4` file system. UNMAP causes to free up space on a thinly-provisioned virtual volume (TPVV) storage volume when data or files are deleted on the `ext4` file system, and requires that the file system be mounted with the `-o discard` option. This feature is useful in maintaining the volume as a thin volume with no storage disk space allocated for files that are deleted. Space is released on the TPVV storage volume when minimum deletions of 16 kilobytes occur in the file system.

Example:

```
# mount -t ext4 -o discard /dev/mapper/350002ac000020121p1 /mnt
```

This will cause the RHEL 6.x OS to issue the UNMAP command, which in turn causes space to be released back to the array from the TPVV volumes for any deletions in that `ext4` file system. This is not applicable for fully-provisioned virtual volumes.

In RHEL 6.x, the default option for creating the `ext2/ext3/ext4` file system has the `-E discard` option enabled for thinly-provisioned virtual volumes (TPVV). This discard option basically causes the host to issue the UNMAP command to unmap all the blocks on the storage volume before the file system is created.

Because the UNMAP commands are issued sequentially, and because there is no need to release blocks on a newly created TPVV (since the storage will not have allocated any space on a TPVV), these UNMAP commands do not serve any purpose for initial file system creation on a new TPVV. Because of the sequential nature of the UNMAP commands issued from the host, file system creation takes a long time on a TPVV by comparison to a fully-provisioned volume.

Therefore, to create the `ext2/ext3/ext4` file system quickly on a newly created TPVV, use the `nodiscard` option. Testing has shown that on a 100 G TPVV, it takes around 3 minutes 30 seconds with a default discard option, and only about 10-12 seconds with `nodiscard` option for the `ext4` default file system.

For example, on a newly created TPVV, use the `-E nodiscard` option:

```
# mkfs.ext4 -E nodiscard /dev/mapper/350002ac000020121p1
```

**NOTE:** Even though the default discard option for creating filesystem is performed on ext2, ext3, or ext4 filesystems, the mount option `-o discard` is supported only on the ext4 filesystem, so the space reclaim operation is also supported only on the ext4 filesystem.

If you are recreating a file system on an existing TPVV, HP recommends that you use the default discard option, as it will free up space on the HP 3PAR StoreServ Storage storage volume for data that was not deleted before recreation.

Example:

```
# mkfs.ext4 /dev/mapper/350002ac000020121p1
```

Use the `showvv -s <VV>` command to get the space details on the storage volume. Here, the `Used` column under `Usr` is the space used by the file system, `Tot_Rsvd` is the space allocated on the storage volume, and `VSize` is the actual size that the file system can grow to, or total volume size. `Tot_Rsvd` will be higher than the `Used` space because of additional space allocated by the system to accommodate new writes and to avoid I/O delays due to volume growth.

In the following example, the host had 60 GB of data on an ext4 file system and files were deleted, causing UNMAP to be issued. Consequently, the file system space is now 25 G and allocated storage space is 60 G.

```
cli % showvv -s rhvol.3
```

		---Adm---				-----Snp-----				-----Usr-----							
		--(MB)--		--(MB)--		--(% VSize)--				--(MB)--		--(% VSize)--				--(MB)--	
Id	Name	Prov	Type	Rsvd	Used	Rsvd	Used	Used	Wrn	Lim	Rsvd	Used	Used	Wrn	Lim	Tot_Rsvd	VSize
96	rhvol.3	tpvv	base	256	66	0	0	0.0	--	--	60928	25172	1.6	0	0	61184	1536000
1	total			256	66	0	0				60928	25172				61184	1536000

After space reclaim and defrag operations are run in the system, the `Tot_Rsvd` space is nearly equal to the `Used` space.

```
root@inoded1062:S289_1# showvv -s rhvol.3
```

		---Adm---				-----Snp-----				-----Usr-----							
		--(MB)--		--(MB)--		--(% VSize)--				--(MB)--		--(% VSize)--				--(MB)--	
Id	Name	Prov	Type	Rsvd	Used	Rsvd	Used	Used	Wrn	Lim	Rsvd	Used	Used	Wrn	Lim	Tot_Rsvd	VSize
96	rhvol.3	tpvv	base	384	148	0	0	0.0	--	--	28928	25172	1.6	0	0	29312	1536000
1	total			384	148	0	0				28928	25172				29312	1536000

The space-reclaim and defrag operations are automatically throttled and run at different time intervals in the system, and space is reclaimed over a given interval of time rather than immediately upon receiving the UNMAP command. The `Used` space will not be the same as is shown in the `df -k` output because of file fragmentation and the way the inode table uses blocks on the system.

## Symantec Space Reclaim Support

Symantec provides space reclaim support on TPVVs using the WRITE SAME SCSI primitive, which is supported by HP 3PAR OS.

Use the `vxdisk -o thin list` to show that the type of disk is `thinrc1m`. The thin reclaim is supported using the `vxdisk reclaim` command. See Symantec documentation for details.

---

# 10 Booting the Host from the HP 3PAR StoreServ Storage

## HP 3PAR StoreServ Storage Setup Requirements

Booting from the HP 3PAR StoreServ Storage is supported in fabric and direct connect modes.

During the RHEL installation process, you will specify the correct argument that will take into account multipathing during the installation process.

Make sure you have allocated enough space when creating your virtual volumes to be able to install your RHEL 6 or RHEL 5 OS.

After creating your first virtual volume, you must export it to your RHEL host as VLUN 0, since RHEL requires the root/boot volume LUN to be 0 when booting from the SAN.

## RHEL Host HBA BIOS Setup Considerations

The HBA BIOS needs to be set up properly to handle booting from the HP 3PAR StoreServ Storage.

### Booting from the HP 3PAR StoreServ Storage Using QLogic HBAs

When booting from the HP 3PAR StoreServ Storage using a QLogic HBA, complete the following steps:

1. During the host boot, press **Ctrl-Q** or **Alt-Q** when prompted for the QLogic Fast!UTIL HBA utility.
2. From the QLogic Fast!UTIL screen, choose **Select Host Adapter** menu and select the host adapter from which you want to boot.
3. When the **Fast!UTIL Options** menu appears, select **Configuration Settings**.
4. Select **Adapter Settings**.
5. Select **Host Adapter BIOS**→**Enabled**, and then press **Esc**.
6. From the Configuration Settings menu, select **Selectable Boot Settings**.
7. From the Selectable Boot Settings menu, select **Selectable Boot**→**Enabled**.
8. Arrow down to the next field, **(Primary) Boot Port Name,LUN**, and then press **Enter**.
9. From the **Select Fibre Channel Device** menu, you should see the HP 3PAR device under ID0 with its Rev, Port Name, and Port ID shown. Press **Enter**.
10. From the **Select LUN** menu, select the first line **LUN 0** with a status of **Supported**, and press **ENTER**.
11. Press **Esc** twice to return to the **Configuration Settings Modified** dialogue box.
12. Select **Save changes**.
13. Return to the **Fast!UTIL Options** menu and select **Select host Adapter**.
14. Select your next HBA port to boot from and repeat these steps.
15. When done, from the **Fast!UTIL Options** menu:
  - a. Select **Exit Fast!UTIL**
  - b. Select **Reboot system**

The settings will be saved and the host is rebooted.

### Booting from the HP 3PAR StoreServ Storage Using Emulex HBAs

When booting from the HP 3PAR StoreServ Storage using an Emulex HBA, complete the following steps:

1. During the host boot, press **Alt-E** or **Ctrl-E** when prompted by the Emulex HBA Utility, a screen appears that will show the Emulex adapters in the system. Select **<Adapter #>** and press **Enter**.
  - a. After that, if a screen is being displayed that says: **The BIOS of the Adapter is Disabled**. If the screen says, **The BIOS of the Adapter is Enabled**, then skip to [Step 2](#).
  - b. Select option 2 **Configure This Adapter's Parameters** and press **Enter**.
  - c. From the next screen Select option 1 **Enable or Disable BIOS** and press **Enter**. The following message appears:  
**The BIOS is Disabled!!**
  - d. Enable **Press 1**, Disable **Press 2**:
  - e. Select 1 and press **Enter**. The following message appears:  
**The BIOS is Enabled!!**
  - f. Press **Esc** twice.
2. Select option 1 **Configure Boot Devices** press **Enter**. The following list appears:  
**List of Saved Boot Devices**
3. Select option 1. **Unused DID:<all zeros> WWPN: <all zeros> LUN:00 Primary Boot** and press **Enter**. The following dialog box appears:  
**01. DID:<did\_value> WWPN:<3PAR Port WWPN> Lun:00 3PARdataVV 0000**
4. Select the two digit number of the desired boot device 01 and press **Enter**. The following dialogue box appears:  
**Enter two digits of starting LUN (Hex):**
5. Type 00 and press **Enter**.  
The following dialog box appears:  
**DID: XXXXXX WWPN: <3PAR port WWPN>**  
**01. Lun:00 3PARdataVV 0000**
  - a. Select 01 and press **Enter**.  
Another dialogue box will appear:  
**1. Boot this device via WWPN**  
**2. Boot this device via DID**
  - b. Select 1 and press **Enter**. The following screen appears:  
**List of saved boot devices**  
**1 Used DID:000000 WWPN:<3PAR Port WWPN> Lun:00 Primary Boot**
6. Press **Esc** twice to return to the Emulex Adapters in the System menu.
7. Select the next HBA port to boot from and repeat these steps.
8. When done, press **x** to exit.
9. You will be prompted to reboot the system. Select **Y**.  
After the system comes up, make sure the RHEL installation CD is in the drive tray to continue with the next steps.

## Installation from RHEL Linux CDs or DVD

Use the following procedure to install from the RHEL 6 or RHEL 5 CDs or DVDs.

### Required

To ensure the root or boot disk is protected by multipath, the multipath option must be enabled at the beginning of the RHEL 5 installation.

1. For RHEL 5.x, when prompted by the install CDs or DVD after the host comes up, at the boot prompt, type the following command:

```
boot: linux mpath
```

This command communicates that multiple paths are connected from the storage to the host.

2. Respond to all the prompts during the install process by selecting the default settings.  
When the installation completes, the host is rebooted.

## Modifying the `/etc/multipath.conf` File

**NOTE:** RHEL 6 uses the default install for a SAN boot.

During an RHEL SAN boot install using the `mpath` option, the `/etc/multipath.conf` file is automatically edited by the install processes. As part of the `/etc/multipath.conf` edits performed during install, the global multipath option `user_friendly_names` enabled.

Note that using the `user_friendly_names` option can be problematic in the following situations:

If the system root device is using multipath and you use the `user_friendly_names` option, the user-friendly settings in the `/var/lib/multipath/bindings` file are included in the `initrd`. If you later change the storage setup, such as by adding or removing devices, there is a mismatch between the bindings setting inside the `initrd` and the bindings settings in `/var/lib/multipath/bindings`.

**CAUTION:** A bindings mismatch between `initrd` and `/var/lib/multipath/bindings` can lead to a wrong assignment of mount points to devices, which can result in file system corruption and data loss.

Use the `alias` option to override the `user_friendly_names` option for the system root device in the `/etc/multipath.conf` file.

Verify that the SAN boot disk created is `/dev/sda`.

```
# fdisk -l -u /dev/sda

Disk /dev/sda: 32.2 GB, 32212254720 bytes
255 heads, 63 sectors/track, 3916 cylinders, total 62914560 sectors
Units = sectors of 1 * 512 = 512 bytes

   Device Boot      Start         End      Blocks    Id  System
/dev/sda1  *           63       208844       104391    83  Linux
/dev/sda2           208845     62910539     31350847+    8e  Linux LVM
```

Identify the `scsi_id` of the boot disk via:

```
# scsi_id -g -u -s /block/sda
350002ac001b90031
```

This identified that `350002ac001b90031` is the WWID of the boot disk in the above example.

Establish an alias name of `mpath0` for the WWID of the boot disk using multipath entries in `/etc/multipath.conf`.

For RHEL 5.0 through RHEL 5.5, the contents of `/etc/multipath.conf` file should be edited as in the following example if the HP 3PAR StoreServ Storage array is running HP 3PAR OS 3.1.1 or later.



**NOTE:** If the HP 3PAR StoreServ Storage array that the RHEL server is connecting to is running an HP 3PAR OS version earlier than 3.1.1, you must change the `no_path_retry` setting to 12 rather than 18, and the `polling_interval` setting to 5 rather than 10.

For RHEL 5.6 or later, the contents of `/etc/multipath.conf` file should be edited as in the following example if the HP 3PAR StoreServ Storage array is running HP 3PAR OS 3.1.1 or later.

**NOTE:** If the HP 3PAR StoreServ Storage array that the RHEL server is connecting to is running an HP 3PAR OS version earlier than 3.1.1, you must change the `no_path_retry` setting to 12 rather than 18, and the `polling_interval` setting to 5 rather than 10.

```
# cat /etc/multipath.conf
defaults {
}
multipaths {
    multipath {
        wwid          350002ac001b90031
        alias         mpath0
    }
}
devices {
    device {
        vendor        "3PARdata"
        product       "VV"
        no_path_retry 18
        features      "0"
        hardware_handler "0"
        path_grouping_policy multibus
        getuid_callout "/sbin/scsi_id -g -u -s /block/%n"
        path_selector  "round-robin 0"
        rr_weight      uniform
        rr_min_io      100
        path_checker   tur
        failback       immediate
        polling_interval 10
    }
}
```

```
# cat /etc/multipath.conf
defaults {
    polling_interval 10
}
multipaths {
    multipath {
        wwid          350002ac001b90031
        alias         mpath0
    }
}
devices {
    device {
        vendor        "3PARdata"
        product       "VV"
        no_path_retry 18
        features      "0"
        hardware_handler "0"
        path_grouping_policy multibus
        getuid_callout "/sbin/scsi_id -g -u -s /block/%n"
        path_selector  "round-robin 0"
        rr_weight      uniform
        rr_min_io      100
        path_checker   tur
        failback       immediate
    }
}
```

For RHEL 6.x, the contents of the `/etc/multipath.conf` file should be edited as in the following example if the HP 3PAR array is running HP 3PAR OS 3.1.1 or later.

**NOTE:** If the HP 3PAR array that the RHEL server is connecting to is running an HP 3PAR OS version earlier than 3.1.1, you must change the `no_path_retry` setting to 12 rather than 18, and the `polling_interval` setting to 5 rather than 10.

**NOTE:** For RHEL 6.1, replace the device keyword `rr_min_io_rq` in the example below with `rr_min_io`. The keyword `rr_min_io_rq` is valid only for RHEL 6.2 and later releases.

```
defaults {
    user_friendly_names    yes
    polling_interval       10
    max_fds                 8192
}
multipaths {
    multipath {
        wwid                350002ac001b90031
        alias               mpath0
    }
}
devices {
    device {
        vendor              "3PARdata"
        product             "VV"
        no_path_retry       18
        features             "0"
        hardware_handler    "0"
        path_grouping_policy multibus
        getuid_callout      "/lib/udev/scsi_id --whitelisted --device=/dev/%n"
        path_selector       "round-robin 0"
        rr_weight            uniform
        rr_min_io_rq        1
        path_checker         tur
        failback             immediate
    }
}
```

After the modifications to the `/etc/multipath.conf` file, restart the multipath daemon or reboot the host so the changes take effect.

```
# chkconfig multipathd off
# chkconfig multipathd on
```

You should find the SAN boot LUN mapped as `mpath0`. In the following example, with a SAN boot LUN ID of 350002ac001b90031:

```
# ls /dev/mapper
control  mpath0  mpath0p1  mpath0p2  VolGroup00-LogVol100  VolGroup00-LogVol101

# multipath -ll
mpath0 (350002ac001b90031) dm-0 3PARdata,VV
[size=20G][features=1 queue_if_no_path][hwhandler=0][rw]
\_ round-robin 0 [prio=2][active]
  \_ 0:0:0:0 sda 8:0    [active][ready]
  \_ 1:0:0:0 sdb 8:16   [active][ready]

# df
Filesystem                1K-blocks      Used Available Use% Mounted on
```

```

/dev/mapper/VolGroup00-LogVol100
14283576    3632732    9913564    27% /
/dev/mapper/mpath0p1    101086    16002    79865    17% /boot
tmpfs    2023232    0    2023232    0% /dev/shm

```

## Changing the Emulex HBA Inbox Driver Parameters

See “[Modifying the /etc/modprobe.conf File and Building the Ramdisk](#)” (page 33) of this document for changing the Emulex HBA parameters and rebuilding the ramdisk.

## Installing the New QLogic Driver

To install a new QLogic driver to replace the Linux inbox driver, complete the following steps:

1. Go to the following website:

[QLogic](#)

Download the driver package `qlafc-linux-<version>-install.tgz` to the RHEL host.

2. To extract the files, run the following command:

```
# tar xvzf qlafc-linux-<version>-install.tgz
```

3. From the directory where the file was extracted, change to the driver directory:

```
# cd qlafc-linux-<version>-install
```

4. Run `qlinstall -upgrade` to install the new driver:

```
# ./qlinstall --upgrade
```

### Required

You must use the `--upgrade` requirement for a successful driver installation.

**NOTE:** You can also use the `-up` option with the `qlinstall` command. Make sure the `-up` or the `-upgrade` option is used when installing the new driver. Upgrade builds and installs the QLogic HBA driver, installs the SNIA HBA API library, creates ramdisk to load driver at boot time, does not load and unload current drivers and does not do persistent binding.

5. After the installation completes, reboot the RHEL host. When the host comes back up, check the driver version:

```
# modinfo qla2xxx |grep version
version:          xx.yy.zz
```

**NOTE:** Modify the HBA parameter to set `qlport_down_retry` to 10 if the HP 3PAR StoreServ Storage array is running HP 3PAR OS 3.1.1 or later. But if the HP 3PAR StoreServ Storage array is running an HP 3PAR OS version earlier than 3.1.1, set `qlport_down_retry` to 1 rather than 10. However, do NOT use the procedure to rebuild the ramdisk as described in “[Building the QLogic Driver](#)” (page 38). Instead, use the `scli` utility that was installed during the driver install process to change this HBA parameter value.

To change the `qlport_down_retry` parameter, issue the following command:

```
# scli
```

After the main menu comes up, select **3: HBA Parameters**.

6. Then, from the **HBA Parameters Menu**, select the HBA that you want to change.
7. Then, from the **HBA Parameters Menu**, select **2: Configure HBA Parameters**.
8. From the **Configure Parameters Menu**, select **13: Port Down Retry Count**.
9. Then enter the value 10 for the **Down Retry Count**: if the HP 3PAR array is running HP 3PAR OS 3.1.1 or later. However, if the HP 3PAR array is running an HP 3PAR OS version earlier than 3.1.1, enter 1.
10. Enter **Port Down Retry Count [0-255] [30]: 10**
11. From the **Configure Parameters Menu**, select **19: Commit Changes**.
12. From the **HBA Parameters Menu**, select **4: Return to Previous Menu**.
13. From the **HBA Parameters Menu**, you can select the next HBA port to repeat the steps to modify its parameter.
14. After finishing, exit the `scli` utility.
15. To ensure that the change has taken effect, run the following command:

```
# cat /proc/scsi/qla2xxx/<hba instance> |grep "Port down retry"
Port down retry = 10
```



**WARNING!** Modifying the `/etc/modprobe.conf` file to make the QLogic HBA `qlport_down_retry` parameter change and using the `mkinitrd` command to rebuild the ramdisk as described in section 3.3.4 will cause the driver not to load and boot properly after rebooting the host.

**NOTE:** The example above shows the QLogic port down retry setting when the RHEL server is connecting to an HP 3PAR StoreServ Storage array running HP 3PAR OS 3.1.1 or later.

**NOTE:** Command to rebuild the new ramdisk:

- For RHEL 6.x: `dracut` command
- For RHEL 5.x: `mkinitrd` command

---

## 11 Using Veritas Cluster Servers

HP supports use with Veritas Cluster Server.

There are no special setup considerations for the HP 3PAR StoreServ Storage.

for installation and setup instructions, see the *Veritas Cluster Server Installation Guide* and *Veritas Cluster Server User's Guide* at the following website:

[Symantec](#)



**CAUTION:** Make sure Device-mapper is disabled if you are using the Veritas DMP as the multipathing solution.

---

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## 12 Using RHEL Xen Virtualization

HP supports the use of RHEL 5 Xen Virtualization.

There are no special setup considerations for the HP 3PAR StoreServ Storage.

See the *RHEL 5 Xen Virtualization Guide* for installation and setup instructions:

[Red Hat](#)

---

## 13 Using RHEL Cluster Services

HP supports RHEL Cluster services for RHEL 4, RHEL 5, and RHEL 6.

For installation and administration RHEL Cluster services, refer to the *RHEL Linux Installation Guide* and *Configuring and Managing an RHEL Cluster* on the following website:

[Red Hat](#)

To manage an RHEL 6.x cluster using the new `luci` and `ricci` method you must set a password for the `ricci` user account created during installation. See the *Red Hat Cluster Deployment Guide* for further information.

There are no special considerations for the HP 3PAR StoreServ Storage besides the standard setup procedures described in this implementation guide.

---

## 14 Using Red Hat Enterprise Virtualization (KVM/RHEV-H)

The Red Hat Enterprise Virtualization Hypervisor (RHEV-H), based on Kernel Virtual Machine (KVM) technology, can be deployed either as a bare metal hypervisor or as an RHEL hypervisor host. The KVM hypervisor requires a processor with the Intel-VT or AMD-V virtualization extensions. The RHEL KVM package is limited to 64-processor cores. A guest OS can be used only on the hypervisor type that they were created on.

For installation, administration, and OS support by the RHEL KVM, refer to the RHEL virtualization guide on the following website:

[Red Hat](#)

There are no special considerations for the HP 3PAR StoreServ Storage besides the standard setup procedures described in this implementation guide.



# 15 Using Oracle Linux

HP supports Oracle Linux with both the RHEL-compatible kernel and with the UEK.

## Oracle Linux with RHEL-Compatible Kernel

When using Oracle Linux with the RHEL-compatible kernel, follow the procedures in this guide for the corresponding version of RHEL.

## Using Oracle Linux with UEK

Oracle Linux UEK is an optimized package for Oracle software and hardware. The Oracle Linux UEK is built upon the RHEL 6 kernel and is optimized specifically for Oracle software.

When using Oracle Linux UEK, follow the usage guide as outlined for the corresponding version of RHEL Linux.

**NOTE:** At the time this guide was released, there was an issue with software iSCSI such that, if iSCSI sessions were opened to exported LUNs from the array, the Oracle Linux host would hang when a system reboot was attempted. A workaround for this issue is to log out of all iSCSI sessions before rebooting the host. Use this command to log out of open iSCSI sessions:

```
# iscsiadm -m node --logout
```

There are no special considerations for the HP 3PAR StoreServ Storage when using Oracle Linux V6.x UEK besides the standard setup procedures described in this implementation guide for RHEL 6.

## Oracle Linux Creating Partitions

When creating Linux-type partitions on exported LUNs using either `fdisk` or `parted`, make sure the correct partitions are listed as partition numbers `p1` or other number. For example, here is an exported LUN displayed using `multipath -ll`:

```
360002ac000000000000000265000185db dm-3 3PARdata,VV
size=15G features='1 queue_if_no_path' hwhandler='0' wp=rw
`-+- policy='round-robin 0' prio=1 status=active
    |- 0:0:0:32 sdd 8:48 active ready running
    |- 1:0:0:32 sdh 8:112 active ready running
```

The following example uses `parted` to create the partition on the exported LUN:

```
parted /dev/skl
GNU Parted 2.1
Using /dev/skl
Welcome to GNU Parted! Type 'help' to view a list of commands.
(parted) mklabel gpt
(parted) unit gb
(parted) mkpart primary
File system type? [ext2]? ext4
Start? 0
End? -0
(parted) p
Modewl: 3APRdata VV (scsi)
Disk /dev/skl: 16.1GB
Sector size (logical/physical): 512B/512B
Partition Table: gpt
```

Number	Start	End	Size	File System	Name	Flags
1	0.02GB	16.1GB	16.1GB	Primary		

```
(parted) q
```

The following example uses `kpartx` to set the device name partition number delimiter:

```
# kpartx -a -p p /dev/mapper/360002ac00000000000000265000185db  
dev/mapper/360002ac00000000000000265000185dbp1: mknod for  
360002ac00000000000000265000185dbp1 failed: File exists
```

In the preceding example, ignore the message `failed: File exists`. The command merely places or changes the partition delimiter character from possibly coming up as only a “1”.

If the value were to come up as a “1” and the partition name delimiter value was not set, and then the host was rebooted, the partition might then change to a value of “P1”, causing issues with any mounts to that specific LUN.

---

## 16 Support for Oracle VM Server

Oracle VM Server is supported with HP 3PAR OS 2.3.1 using host persona 6 as documented in *HP 3PAR Additional Hardware Support For Inform OS 2.3.1* located in the HP SPOCK website:

[HP SPOCK](#)

To configure Device-mapper multipathing, see “[Setting Up Multipathing Software](#)” (page 48), as the procedure is same as that of RHEL. For all Oracle VM support with 3PAR OS 3.1.1 and later, file a Deal Exception Request/Customer Enhancement Request through your HP representative.

# 17 Support and Other Resources

## Contacting HP

For worldwide technical support information, see the HP support website:

<http://www.hp.com/support>

Before contacting HP, collect the following information:

- Product model names and numbers
- Technical support registration number (if applicable)
- Product serial numbers
- Error messages
- Operating system type and revision level
- Detailed questions

Specify the type of support you are requesting:

HP 3PAR storage system	Support request
HP 3PAR StoreServ 7200, 7400, and 7450 Storage systems	StoreServ 7000 Storage
HP 3PAR StoreServ 10000 Storage systems HP 3PAR T-Class storage systems HP 3PAR F-Class storage systems	3PAR or 3PAR Storage

## HP 3PAR documentation

For information about:	See:
Supported hardware and software platforms	The HP Storage Products (SPOCK) website: <a href="http://www.hp.com/storage/spock">http://www.hp.com/storage/spock</a>
Locating HP 3PAR documents	The HP 3PAR StoreServ Storage site: <a href="http://www.hp.com/go/3par">http://www.hp.com/go/3par</a> To access HP 3PAR documents, click the <b>Support</b> link for your product.
<b>HP 3PAR storage system software</b>	
Storage concepts and terminology	<i>HP 3PAR StoreServ Storage Concepts Guide</i>
Using the HP 3PAR Management Console (GUI) to configure and administer HP 3PAR storage systems	<i>HP 3PAR Management Console User's Guide</i>
Using the HP 3PAR CLI to configure and administer storage systems	<i>HP 3PAR Command Line Interface Administrator's Manual</i>
CLI commands	<i>HP 3PAR Command Line Interface Reference</i>
Analyzing system performance	<i>HP 3PAR System Reporter Software User's Guide</i>
Installing and maintaining the Host Explorer agent in order to manage host configuration and connectivity information	<i>HP 3PAR Host Explorer User's Guide</i>
Creating applications compliant with the Common Information Model (CIM) to manage HP 3PAR storage systems	<i>HP 3PAR CIM API Programming Reference</i>


<b>For information about:</b>	<b>See:</b>
Migrating data from one HP 3PAR storage system to another	<i>HP 3PAR-to-3PAR Storage Peer Motion Guide</i>
Configuring the Secure Service Custodian server in order to monitor and control HP 3PAR storage systems	<i>HP 3PAR Secure Service Custodian Configuration Utility Reference</i>
Using the CLI to configure and manage HP 3PAR Remote Copy	<i>HP 3PAR Remote Copy Software User's Guide</i>
Updating HP 3PAR operating systems	<i>HP 3PAR Upgrade Pre-Planning Guide</i>
Identifying storage system components, troubleshooting information, and detailed alert information	<i>HP 3PAR F-Class, T-Class, and StoreServ 10000 Storage Troubleshooting Guide</i>
Installing, configuring, and maintaining the HP 3PAR Policy Server	<i>HP 3PAR Policy Server Installation and Setup Guide</i> <i>HP 3PAR Policy Server Administration Guide</i>

For information about:	See:
<b>Planning for HP 3PAR storage system setup</b> Hardware specifications, installation considerations, power requirements, networking options, and cabling information for HP 3PAR storage systems	
HP 3PAR 7200, 7400, and 7450 storage systems	<i>HP 3PAR StoreServ 7000 Storage Site Planning Manual</i> <i>HP 3PAR StoreServ 7450 Storage Site Planning Manual</i>
HP 3PAR 10000 storage systems	<i>HP 3PAR StoreServ 10000 Storage Physical Planning Manual</i> <i>HP 3PAR StoreServ 10000 Storage Third-Party Rack Physical Planning Manual</i>
<b>Installing and maintaining HP 3PAR 7200, 7400, and 7450 storage systems</b>	
Installing 7200, 7400, and 7450 storage systems and initializing the Service Processor	<i>HP 3PAR StoreServ 7000 Storage Installation Guide</i> <i>HP 3PAR StoreServ 7450 Storage Installation Guide</i> <i>HP 3PAR StoreServ 7000 Storage SmartStart Software User's Guide</i>
Maintaining, servicing, and upgrading 7200, 7400, and 7450 storage systems	<i>HP 3PAR StoreServ 7000 Storage Service Guide</i> <i>HP 3PAR StoreServ 7450 Storage Service Guide</i>
Troubleshooting 7200, 7400, and 7450 storage systems	<i>HP 3PAR StoreServ 7000 Storage Troubleshooting Guide</i> <i>HP 3PAR StoreServ 7450 Storage Troubleshooting Guide</i>
Maintaining the Service Processor	<i>HP 3PAR Service Processor Software User Guide</i> <i>HP 3PAR Service Processor Onsite Customer Care (SPOCC) User's Guide</i>
<b>HP 3PAR host application solutions</b>	
Backing up Oracle databases and using backups for disaster recovery	<i>HP 3PAR Recovery Manager Software for Oracle User's Guide</i>
Backing up Exchange databases and using backups for disaster recovery	<i>HP 3PAR Recovery Manager Software for Microsoft Exchange 2007 and 2010 User's Guide</i>
Backing up SQL databases and using backups for disaster recovery	<i>HP 3PAR Recovery Manager Software for Microsoft SQL Server User's Guide</i>
Backing up VMware databases and using backups for disaster recovery	<i>HP 3PAR Management Plug-in and Recovery Manager Software for VMware vSphere User's Guide</i>
Installing and using the HP 3PAR VSS (Volume Shadow Copy Service) Provider software for Microsoft Windows	<i>HP 3PAR VSS Provider Software for Microsoft Windows User's Guide</i>
Best practices for setting up the Storage Replication Adapter for VMware vCenter	<i>HP 3PAR Storage Replication Adapter for VMware vCenter Site Recovery Manager Implementation Guide</i>
Troubleshooting the Storage Replication Adapter for VMware vCenter Site Recovery Manager	<i>HP 3PAR Storage Replication Adapter for VMware vCenter Site Recovery Manager Troubleshooting Guide</i>
Installing and using vSphere Storage APIs for Array Integration (VAAI) plug-in software for VMware vSphere	<i>HP 3PAR VAAI Plug-in Software for VMware vSphere User's Guide</i>

# Typographic conventions

Table 4 Document conventions

Convention	Element
<b>Bold text</b>	<ul style="list-style-type: none"><li>• Keys that you press</li><li>• Text you typed into a GUI element, such as a text box</li><li>• GUI elements that you click or select, such as menu items, buttons, and so on</li></ul>
Monospace text	<ul style="list-style-type: none"><li>• File and directory names</li><li>• System output</li><li>• Code</li><li>• Commands, their arguments, and argument values</li></ul>
<Monospace text in angle brackets>	<ul style="list-style-type: none"><li>• Code variables</li><li>• Command variables</li></ul>
<b>Bold monospace text</b>	<ul style="list-style-type: none"><li>• Commands you enter into a command line interface</li><li>• System output emphasized for scannability</li></ul>

 **WARNING!** Indicates that failure to follow directions could result in bodily harm or death, or in irreversible damage to data or to the operating system.

 **CAUTION:** Indicates that failure to follow directions could result in damage to equipment or data.

**NOTE:** Provides additional information.

## Required

Indicates that a procedure must be followed as directed in order to achieve a functional and supported implementation based on testing at HP.

## HP 3PAR branding information

- The server previously referred to as the "InServ" is now referred to as the "HP 3PAR StoreServ Storage system."
- The operating system previously referred to as the "InForm OS" is now referred to as the "HP 3PAR OS."
- The user interface previously referred to as the "InForm Management Console (IMC)" is now referred to as the "HP 3PAR Management Console."
- All products previously referred to as "3PAR" products are now referred to as "HP 3PAR" products.

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## 18 Documentation feedback

HP is committed to providing documentation that meets your needs. To help us improve the documentation, send any errors, suggestions, or comments to Documentation Feedback ([docsfeedback@hp.com](mailto:docsfeedback@hp.com)). Include the document title and part number, version number, or the URL when submitting your feedback.